NIOSH EXTRAMURAL RESEARCH AND TRAINING PROGRAM

ANNUAL REPORT OF FISCAL YEAR 2016

Prepared by the Office of Extramural Programs | National Institute for Occupational Safety and Health

Centers for Disease Control and Prevention
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Sarah A. Felknor, DrPH; Donjanea F. Williams, EdD; and Peter Grandillo, MBA

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

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FOREWORD

I am pleased to deliver the FY2016 annual report on the extramural research and training program of NIOSH. This special issue of the annual report marks the end of the second decade of the National Occupational Research Agenda (NORA). It reviews how the extramural research program has contributed to improving workplace safety and health over the past 10 years.

We report on how NIOSH invested in our multidisciplinary centers, investigator-initiated research projects, and cooperative research agreements. We also report on our training project grants, state surveillance programs, small business innovation research, and global health initiatives. This report doesn't include World Trade Center Health Program (WTCHP) grants. Information about the WTCHP is available on the NIOSH website.

We analyzed funding and activity by each NORA program area, and reviewed integrated research for each NORA sector strategic goal. We include links to the NIOSH website throughout the report, giving instant access to additional relevant data and information. The appendices report on other highlights of FY2016, including the public health relevance and impact of our extramural portfolio.

This special issue of the annual report also shows the investment in extramural research during the second decade of NORA, 2006–2016. The full report on NORA's second decade is included in the report, National Occupational Research Agenda: Second Decade in Review, 2006–2016.

We acknowledge the extramural research community's work to protect the workforce by producing new occupational safety and health knowledge and transferring it into practice.

John Howard, MD
Director, National Institute for
Occupational Safety and Health
Centers for Disease Control and Prevention

EXECUTIVE SUMMARY

In FY2016, NIOSH funded 186 extramural awards totaling $97,799,835—an increase of $1,025,568 over FY2015's total of $96,774,267.

Multidisciplinary centers received 36 awards totaling $55,417,158 (57%) in these program areas:

- $28.0 million for 18 Education and Research Centers (ERCs)
- $16.0 million for 11 Agriculture Safety and Health Centers (Ag Centers)
- $5.8 million for 1 National Center for Construction Research and Training
- $5.7 million for 6 Centers of Excellence for *Total Worker Health®*

Investigator-initiated and career development research received 68 awards totaling $22,985,270 (23%). Cooperative research agreements received 42 awards totaling $11,562,722 (12%). Specialty training programs received 31 awards totaling $5,785,944 (6%), and nine small business innovation research projects received a total of $2,048,741 (2%).

Funding for global health initiatives included a cooperative agreement with the World Health Organization (WHO) for $249,993 to support the Global Plan of Action on Workers' Health, which works to strengthen the capacities of national health systems to respond to the specific health needs of workers.

NIOSH continued its long-standing support of global occupational health research and training by cosponsoring the NIH Fogarty International Center Global Environmental and Occupational Health Hubs. This program supports institutions in low- and middle-income countries that serve as regional hubs for collaborative research and training in responding to high-priority environmental and occupational health threats.

In FY2016, NIOSH extramural researchers wrote 582 peer-reviewed articles in 287 journals, an increase of 110 articles over FY2015. Education and Research Centers had the most articles (215) published, followed by investigator-initiated R01 research (158). In FY2016, NIOSH extramural researchers most often published articles in the *Journal of Occupational and Environmental Medicine*.

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

SECTOR PROGRAMS

ALL	All Sectors or Multiple Sectors
AFF	Agriculture, Forestry and Fishing
CON	Construction
HSA	Healthcare and Social Assistance
MNF	Manufacturing
MIN	Mining
MIO	Oil and Gas Extraction
SPS	Public Safety
SRV	Services
TWU	Transportation, Warehousing and Utilities
WRT	Wholesale and Retail Trade

LIST OF FIGURES

LIST OF TABLES

I. NIOSH EXTRAMURAL RESEARCH AND TRAINING PORTFOLIO

NIOSH Extramural Research and Training Programs include multidisciplinary research and training centers, investigator-initiated research, mentored research scientist development awards, training project grants, and small business innovation research projects in occupational safety and health. State surveillance programs and global occupational health initiatives complement the breadth and depth of extramural research and training at NIOSH. The Research and Training Portfolio webpage describes these programs. The NIH Guide for Grants and Contracts publishes extramural funding opportunity announcements, which are also included in the Funding Opportunities listed on the NIOSH Extramural Research and Training Programs webpage. Appendix 1 lists all the NIOSH funding opportunity announcements published in FY2016.

NATIONAL OCCUPATIONAL RESEARCH AGENDA

The National Occupational Research Agenda (NORA) is a partnership program to stimulate innovative research and improved workplace practices. Unveiled in 1996, NORA has become a research framework for the nation and NIOSH that identifies and addresses the most pressing issues in occupational safety and health. NORA partners work together to develop goals and objectives to address specific, recognized needs through innovative research that is followed by research to practice (r2p) actions. This r2p focus is central to NIOSH-funded research. The r2p webpage offers more information on the NIOSH r2p program.

The Second Decade of NORA structure applied to the NIOSH program portfolio in FY2016. This structure consisted of 10 NORA industry sector programs and 24 cross-sector programs representing major occupational safety and health issues and non-health outcomes. Each program area establishes research priorities and goals, which include priority goals for the extramural program. Table 1 offers links to more information about these program areas and research priorities.

NORA SECOND DECADE IN REVIEW

NORA operates in 10-year cycles, with the second decade of NORA ending in FY2016. NIOSH reviewed activities over the second decade (2006–2016),* and this annual report includes a look back at 10 years of contributions to improving workplace health and safety. The NORA Second Decade in Review Report and the Sector and Cross-Sector Program Supplement offer more information about the second decade of NORA.

*NORA is not organized by calendar year, so a 10-year NORA cycle spans 11 calendar years.

NIOSH PROGRAM AREAS

Table 1. NIOSH Program Areas

NIOSH Sector Program Areas	
Agriculture, Forestry and Fishing	Oil and Gas Extraction
Construction	Public Safety
Healthcare and Social Assistance	Services
Manufacturing	Transportation, Warehousing and Utilities
Mining	Wholesale and Retail Trade
NIOSH Health Outcome Cross-Sector Program areas	
Cancer, Reproductive and Cardiovascular Diseases	Respiratory Diseases
Hearing Loss Prevention	Traumatic Injury
Immune and Dermal Diseases	Work Organization and Stress Disorders
Musculoskeletal Disorders	
Non-health Outcome Cross-Sector Program Areas	
Authoritative Recommendations	Occupational Health Disparities
Communications and Information Dissemination	Personal Protective Technology
Economics	Prevention Through Design
Emergency Preparedness and Response	Radiation Dose Reconstruction
Engineering Controls	Small Business Assistance and Outreach
Exposure Assessment	Surveillance
Global Collaborations	*Total Worker Health®*
Health Hazard Evaluation	Training Grants
Nanotechnology	

*Click on a program area name to follow a link to webpages offering more information. This list shows the program names in FY2016.

II. NIOSH EXTRAMURAL RESEARCH

FUNDING DISTRIBUTION FY2016

In FY2016, NIOSH awarded $97,799,835 in extramural funding. The distribution of awards by type of activity is shown in Figure 1. Fifty-seven percent (57%) of the extramural funding went to multidisciplinary centers, followed by 23% for investigator-initiated and career development research grants. Other cooperative research agreements made up 12% of the FY2016 portfolio, followed by specialty training programs (6%), and small business innovation research projects (2%).

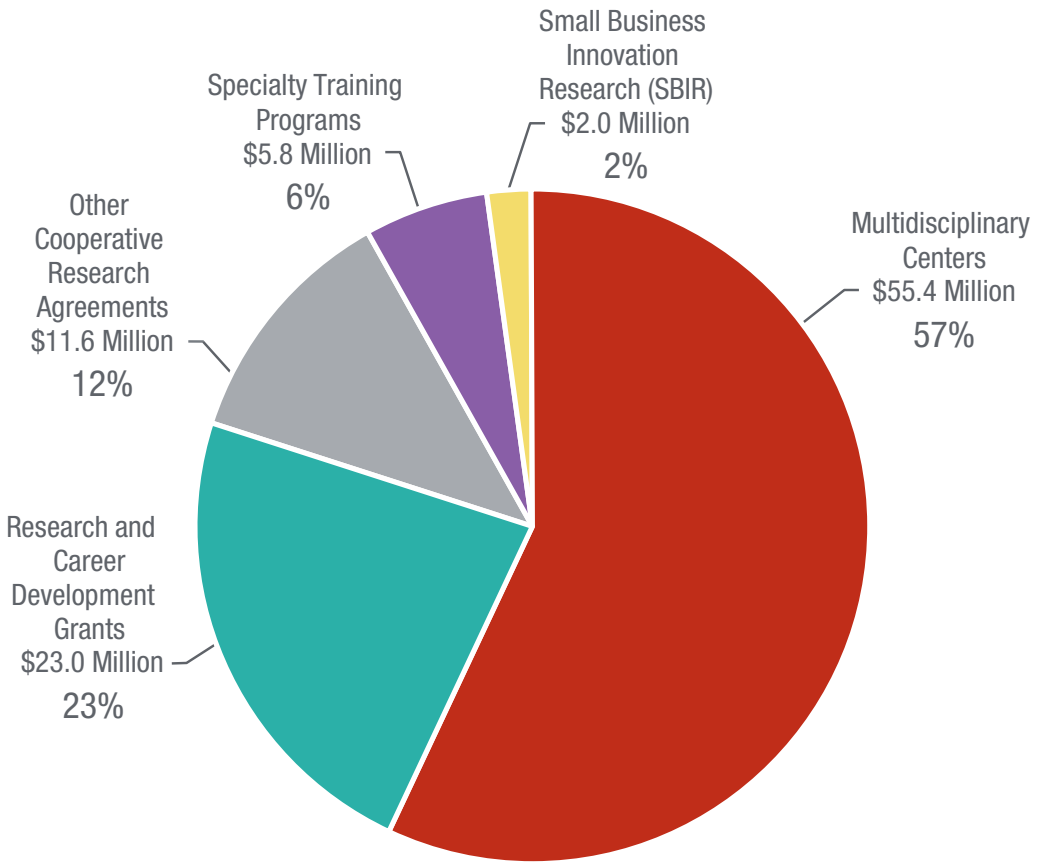


Figure 1. NIOSH extramural grant distribution, FY2016

In FY2016, NIOSH presented 186 awards. Of these, 62 (33%) were for new projects, while 124 (67%) were continuing awards. Table 2 is a summary of all NIOSH extramural awards for FY2016. Of the 186 awards made,

- 36 (19%) funded multidisciplinary research and training centers, which include Education and Research Centers, Agriculture Safety and Health Centers (Ag Centers), CPWR—The Center for Construction Research and Training, and Centers of Excellence for *Total Worker Health*®;
- 68 (37%) funded investigator-initiated research and career development;
- 42 (23%) funded cooperative research agreements;
- 31 (17%) funded training program grants; and
- 9 (5%) funded small business innovation research.
- A searchable listing of all active awards funded by NIOSH is available on the Office of Extramural Programs (OEP) webpage.

SUMMARY OF ALL AWARDS BY TYPE OF FUNDING

Table 2. Summary of all awards by type of funding in FY2016

Award category	Award mechanism	Number of awards	Funding
Multidisciplinary Centers		36	$55,417,158
Education and Research Centers	Training Grant (T42)	18	$27,956,791
Agriculture Safety and Health Centers	Cooperative Research Agreement (U54)	11	$16,041,284
National Center for Construction Research and Training	Cooperative Research Agreement (U60)	1	$5,750,000
Centers of Excellence for *Total Worker Health®*	Cooperative Research Agreement (U19)	6	$5,669,083
Investigator-initiated Research Grants		68	$22,985,270
Research Grants	Investigator-initiated (R01, R03, R21,R13, U13)	57	$21,797,538
Career Developmental Research	Mentored Career Scientist (K01)	11	$1,187,732
Cooperative Research Agreements		42	$11,562,722
Surveillance	Cooperative Research Agreement (U60)	26	$6,761,511
Workers Compensation Surveillance	Cooperative Research Agreement (U60)	5	$998,279
Agricultural, Forestry and Fishing Safety and Health	Cooperative Research Agreement (U01)	9	$2,474,278
National Mesothelioma Virtual Bank	Cooperative Research Agreement (U24)	1	$1,078,661
World Health Organization	Cooperative Research Agreement (E11)	1	$249,993
Specialty Training Programs		31	$5,785,944
Training Project Grants	T01 and T03	28	$4,213,119
Miner Safety and Health Training Program	Cooperative Research Agreement (U60)	3	$1,572,825
Small Business Innovation Research		9	$2,048,741
Small Business Innovation Research	Phase I (R43) & Phase II (R44)	9	$2,048,741
Total Extramural Funding		186	$97,799,835

EXTRAMURAL RESEARCH PORTFOLIO FY2016

The NIOSH extramural research portfolio includes multidisciplinary centers, investigator-initiated research, and cooperative agreements. All applications for extramural funding are peer-reviewed for scientific merit and reviewed internally for programmatic relevance. The section below describes the elements of the NIOSH extramural research portfolios.

Multidisciplinary Centers

NIOSH funds targeted research and outreach activities through multidisciplinary centers, focusing on high-risk industries that contribute disproportionately to occupational injury and illness in the United States. A variety of grant mechanisms, including cooperative research agreements and center training grants, fund these centers. The Agriculture Safety and Health Centers (Ag Centers) and CPWR—The Center for Construction Research and Training perform critical research and training into the many safety and health hazards in agriculture and construction.

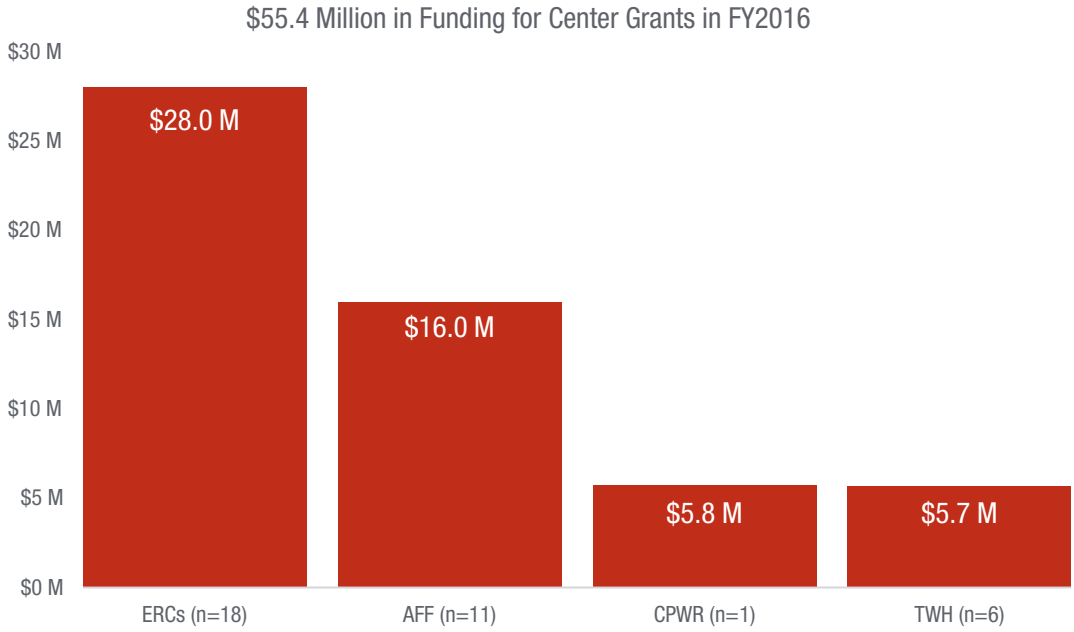
Centers of Excellence for *Total Worker Health®* offer a multidisciplinary and multifactorial approach to worker health and wellbeing. The activities of these centers reflect a broader understanding of the critical relationship between work, health, and productivity.

Multidisciplinary education and research activities are carried out through a national network of Education and Research Centers (ERCs). ERCs are university-based centers that provide graduate training in the core and allied fields of occupational safety and health. In addition to degree training, ERCs provide continuing education and outreach to the occupational safety and health community throughout the federal health region they serve.

NIOSH awarded about $55.4 million to 36 multidisciplinary centers in FY2016:

- 18 ERCs received $28 million.
- 11 Ag Centers received $16 million.
- CPWR—The Center for Construction Research and Training received $5.8 million.
- 6 Centers of Excellence for *Total Worker Health®* received $5.7 million (see Figure 2).

Appendix 2 describes each of these center portfolios and lists individual center grants.



ERCs = Education and Research Centers; AFF = Agriculture, Forestry and Fishing; CPWR = National Center or Construction Research and Training; and TWH = Centers of Excellence for Total Worker Health®

Figure 2. Multidisciplinary center awards, FY2016

Investigator-initiated Research

Research Grants

Through its funding awards for investigator-initiated research, the NIOSH extramural research program supports relevant, quality scientific investigations that will help reduce occupational injuries and illnesses. These diverse awards include funding for large occupational safety and health research projects (R01), small occupational safety and health research grants (R03), and exploratory occupational safety and health research grants (R21). The extramural research portfolio includes research scientist career development awards (K01), which provide mentored training for the next generation of occupational safety and health scientists. These competitive K01 awards provide up to 3 years of funding and a scientific focus designed to develop the skills and productivity of new career scientists. NIOSH awarded $23 million to new and continuing research projects and mentored scientist grants in FY2016 (see Table 3). Appendix 2 describes investigator-initiated research outputs.

Conference Grants

NIOSH values quality scientific meetings that can help prevent injuries, illnesses, and fatalities caused by hazards in the workplace. Conference grants are awarded under research grant mechanisms (R13 and U13). In FY2016, NIOSH funded three R13 conference grants and one U13 cooperative agreement conference grant (see Table 3).

Table 3. Investigator-initiated research and conference grant funding, FY2016

Type of grant	New awards	New funding	Continuing awards	Continuing funding	Total funding
R01	9	$4,563,719	34	$15,606,063	$20,169,782
R21	2	$ 442,567	4	$ 797,128	$1,239,695
K01	2	$ 216,000	9	$ 971,732	$1,187,732
R03	1	$ 76,997	3	$ 221,064	$298,061
R13	2	$ 40,000	1	$20,000	$60,000
U13	1	$ 30,000	0	$0	$30,000
Total	17	$5,369,283	51	$17,615,987	$22,985,270

Cooperative Agreements

NIOSH uses cooperative agreements to arrange collaborative surveillance and research opportunities with state health departments, universities, labor unions, and nonprofit organizations. NIOSH funds a broad array of cooperative agreements to develop knowledge for preventing occupational diseases and injury.

Unlike grants, which are conducted independently of the sponsoring agency, cooperative agreements bring together the expertise of federal and nonfederal researchers to accomplish public health efforts that would not otherwise occur. A cooperative agreement requires a clear need for a program's staff to perform the proposed project. NIOSH evaluates whether the cooperative agreement is of sufficient priority to warrant committing staff resources needed to collaborate during the term of the cooperative agreement award.

Cooperative research agreements funded in FY2016 totaled $11.6 million and included long-standing state surveillance programs and the second year of funding for workers' compensation surveillance. AFF funding to support forestry safety research was also funded, along with the National Mesothelioma Virtual Bank and support for the World Health Organization's Global Health Program. Figure 3 shows how NIOSH distributes funds and how many cooperative research agreements receive funding.

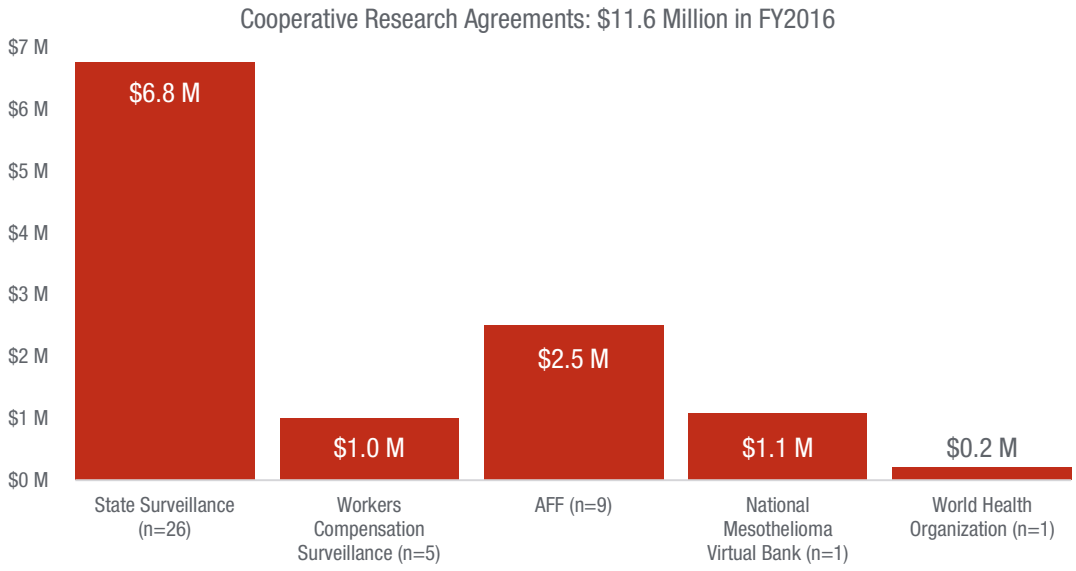


Figure 3. Cooperative agreements, FY2016

State Surveillance Program

The state surveillance program helps states develop capacity to monitor occupational injuries, illnesses, and fatalities. This program helps expand the role of states in conducting in-depth surveillance and follow-up through investigations and interventions. These 26 NIOSH-sponsored programs contribute to a national occupational health surveillance strategy for identifying workplace injury and illness and opportunities for research and intervention. The State Surveillance Portfolio Annual Performance Reports focus on these state-based initiatives. Table 2 reports the total number and funding for all state surveillance awards (new and continuing) for FY2016.

Workers' Compensation Surveillance

The Workers' Compensation Surveillance Cooperative Agreement compiles, analyzes, and disseminates workers' compensation data. This collaboration works to prevent occupational injuries, illnesses, fatalities, and hazards within states and across the nation. These agreements provide resources to state health and workers' compensation agencies, allowing them to start or expand state-based workers' compensation surveillance and partnering efforts. States can use their data to find trends and emerging issues, along with high-risk occupations, industries, and worker populations. In FY2016, NIOSH awarded three new awards to Michigan State University, Ohio State Bureau/Workers' Compensation, and University of Tennessee–Knoxville.

Agriculture, Forestry and Fishing

The NIOSH Office of Agriculture Safety and Health began this research cooperative agreement program in FY2014 to accomplish the following:

- Further the understanding of risks and conditions associated with forestry- or logging-related occupational injuries, illnesses, and fatalities.
- Explore methods to reduce risks and prevent or minimize exposure to hazardous conditions in these work environments.
- Translate significant scientific findings into prevention practices and products that will effectively reduce work-related injuries, illnesses, and fatalities in this area.

The cooperative agreement program also enhances knowledge about the effectiveness of existing interventions and the best ways to disseminate, diffuse, and translate proven interventions to benefit workers in this sector—in particular the ability to address the unique needs of vulnerable workers.

National Mesothelioma Virtual Bank

The National Mesothelioma Virtual Bank advances translational research for the scientific community by collecting quality data and biospecimens for mesothelioma. This resource gives researchers access to de-identified clinical data associated with a multitude of biospecimens. It will support scientific discovery, improve detection, and help develop effective treatments for mesothelioma. This work supports research that addresses the complex mechanisms and biological changes associated with mesothelioma and its disease progression. The National Mesothelioma Virtual Bank may ultimately help improve the quality of life of current and former workers who have malignant mesothelioma.

Global Partnerships

Global partnerships help NIOSH accomplish its mission of leading the nation and world in preventing work-related injuries, illnesses, and fatalities. Global collaborations can take the form of participating in the World Health Organization (WHO) global network for occupational health as a collaborating center, forming partnerships to investigate alternative approaches to workplace illness and injury reduction and provide technical assistance to put solutions in place, performing international collaborative research, and building global professional capacity to address workplace hazards through training, information sharing and research experience.

NIOSH supports global occupational safety and health initiatives through long-standing collaborations with the World Health Organization. NIOSH has been the WHO Collaborating Center in Occupational Health since 1976. NIOSH has been involved in program planning; collaborative research, training, and management; and interacting with WHO's Program on Workers' Health. Additional support of global health activities included cosponsoring the National Institutes of Health (NIH) Fogarty International Center Global Environmental and Occupational Health (GEOHealth) program. This interagency agreement has supported dozens of research training grants across the globe designed to prepare the next generation of scientists, researchers, and practitioners to effectively deal with the increasing burden of occupational injury and illness. The program aims to support and catalyze a multi-national network of regional hubs led by an institution in low- or middle-income countries and a United States institution to conduct research and research training, develop relevant curricula, and support the science needed to inform nationally-relevant policy development. The GEOHealth website has more information about the global health collaboration with NIH and other partners.

Specialty Training Programs

Along with the ERCs described under "Multidisciplinary Centers" above, NIOSH supports professional training in occupational safety and health in single disciplines through Training Project Grants (TPGs). Most TPGs are academic training programs that support undergraduate and graduate training. These programs throughout the United States complement the national network of graduate training that ERCs provide.

NIOSH funds the Emergency Responder Training Program, a TPG, through the International Association of Fire Fighters. This grant supports a comprehensive, nationwide hazardous substance training program for firefighters, paramedics, and other emergency responders across the United States.

The Miner Safety and Health Training Program–Western United States cooperative agreement connects the mining community with mining-relevant information, resources, and methods that increase the capacity and efficacy of safety training for western states' miners. The Western Mining Safety and Health Training Resource Center provides these programs and activities at the University of Arizona, along with the Energy, Mining and Construction Industry Safety Program at the Colorado School of Mines, and the University of Texas at Arlington Division for Enterprise Development.

Table 2 shows the number and funding of all specialty-training grants (new and continuing) awarded in FY2016.

Small Business Innovation Research

The Small Business Innovation Research (SBIR) program helps stimulate the private sector to innovate technology. The SBIR program also helps small businesses commercially apply federally supported research, helping them meet federal research needs as well as their own research and development needs. The SBIR program funds small businesses in their early stages as they commercialize innovative technologies for occupational safety and health. This competitive program helps small businesses participate in federal research and development, produce life-saving technologies, and create jobs. Improving the return on investment from federally funded research boosts the nation's economy and improves society. NIOSH solicits Phase I and Phase II research proposals from science and technology-based firms. Phase II proposals are limited to small businesses that have successfully completed their Phase I projects. Table 2 shows awards and funding for all FY2016 SBIR grants.

EXTRAMURAL RESEARCH ACTIVITY BY NIOSH PROGRAM AREA

The Second Decade of NORA sector structure organizes the NIOSH research program portfolio. Extramural research in FY2016 took place across all NIOSH sector program areas. Figure 4 shows FY2016 funding for investigator-initiated research and career development research across NORA sectors. Figure 4 shows that in FY2016, projects in the Healthcare and Social Assistance Sector received the most funding, followed by Manufacturing and All Sectors.

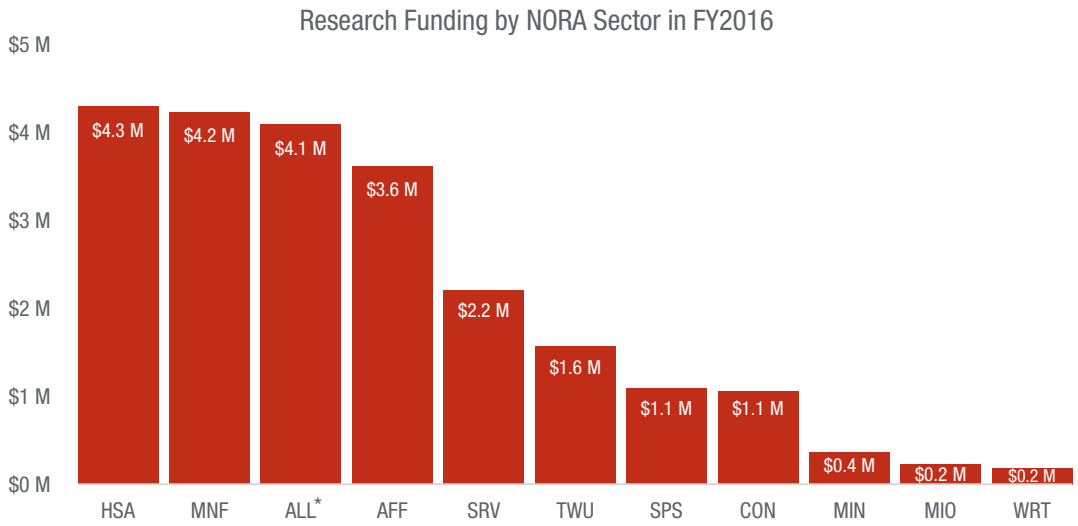


Figure 4. Research funding by sector program, FY2016

*Shows projects that contribute to advancing all or most of the NIOSH sector programs, includes public health activities tools that cut across NORA industry sectors.

SUCCESS RATES FOR RESEARCH PROJECT GRANTS IN FY2007–FY2016

The success rate is the percentage of reviewed applications that receive funding in a given fiscal year. Success rates help measure the viability of the research grants program. Success rates for new awards are calculated for the investigator-initiated research only, which includes the R01, R03, and R21 grant mechanisms.

In FY2016, NIOSH gave 12 new research awards (R01, R03, and R21 combined) out of 188 new applications (Figure 5), resulting in a 6% success rate. FY2016 had 23 more applications than FY2015, when NIOSH received 165 applications. The success rate is a function of the number of applications received and the number of applications funded. The success rate remained stable from 2007 through 2014, but has decreased since 2015 to its lowest percentage (6%). For the FY2007–FY2016, the mean annual number of applications was 173, the mean number of awards was 29, and the mean annual success rate was 17%.

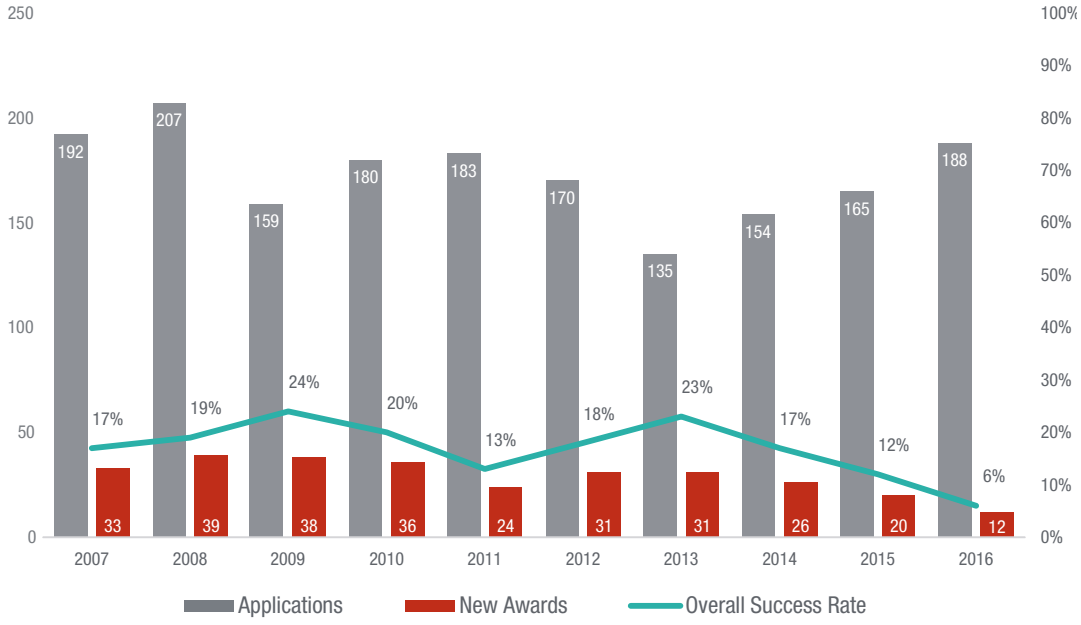


Figure 5. Overall success rates for research project grants

R01 Success Rates

Figure 6 shows the success rates for R01 applications from FY2007 to FY2016. The success rate over time has remained somewhat stable, with a high of 28% in FY2010 and low points in FY2011 (14%), FY2012 (13%) and FY2016 (11%). However, while the number of applications declined from 135 in FY2007 to 58 in FY2014, this figure rose to 81 in FY2016. There has also been a decline in the number of new R01 awards, from a high of 29 new awards in FY2008 to a low of nine awards in FY2012 and FY2016. New awards declined after FY2008 to nine awards in FY2012 and then increased slightly before declining to nine awards again in FY2016.

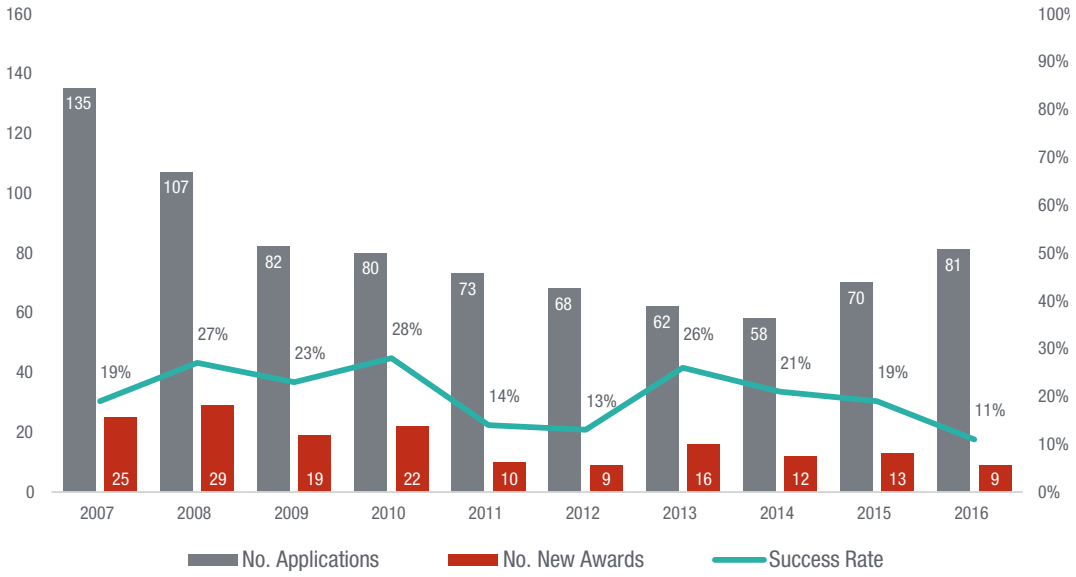


Figure 6. Success rates for R01 applications, FY2007–FY2016

R03 Success Rates

Figure 7 shows R03 applications and new awards made annually from FY2007 to FY2016. Except for a sharp increase in the success rates to 30% in 2009, and a decrease to a low of a 3% success rate in FY2016, rates have remained stable from FY2007 through FY2016.

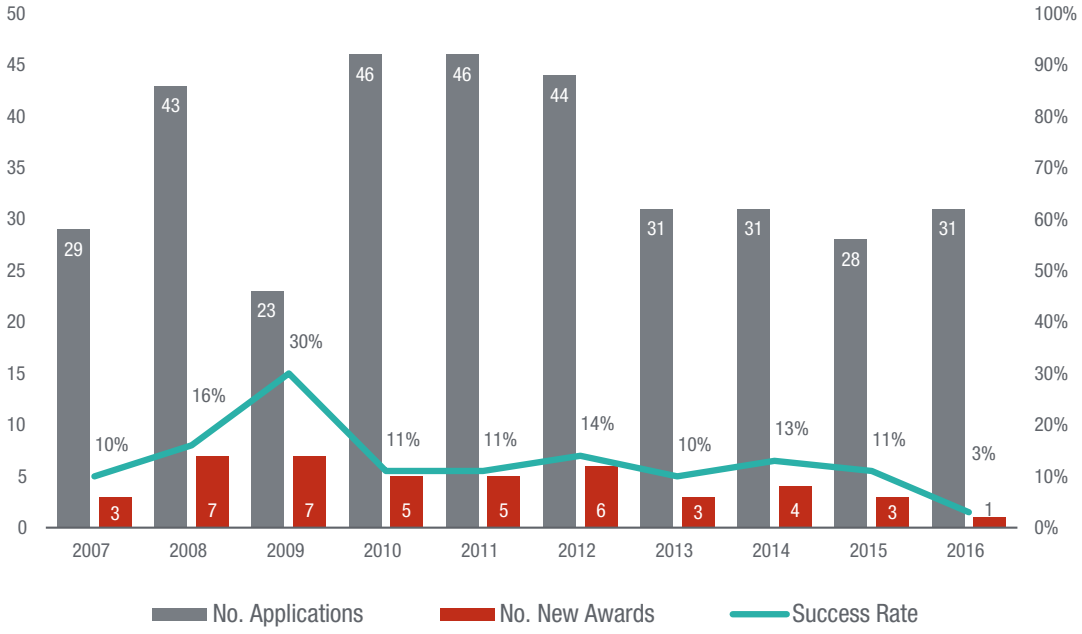


Figure 7. Success rates for R03 applications, FY2007–FY2016

R21 Success Rates

Figure 8 shows R21 applications and new awards made from FY2007 to FY2016. R21 applications increased substantially over this time, reaching a high of 76 applications in FY2016. New awards in FY2016 (two awards) marked its lowest point, although the trend remained fairly stable from FY2009 through FY2014, peaking with 16 new awards in FY2012. Awards started to significantly decline in FY2015.

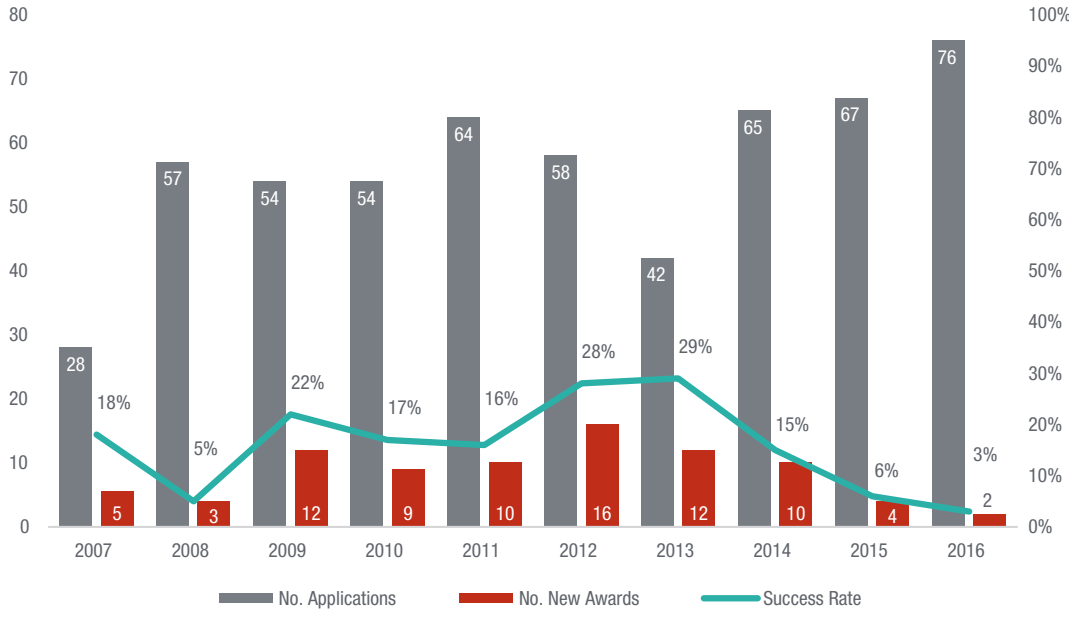


Figure 8. Success rates for R21 applications, FY2007–FY2016

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III. RESEARCH INTEGRATION IN FY2016

Research integration at NIOSH strategically aligns research, making it more productive through coordinating, cooperating, and collaborating across intramural and extramural programs. One way to measure integrated research programs is to count sector program goals that intramural and extramural research address. NIOSH annually assesses intramural and extramural projects that address strategic goals in the NORA Sector Agendas. NORA sector councils, co-chaired by NIOSH, identified strategic goals to address the most pressing occupational safety and health issues workers face. Intramural and extramural researchers address these goals through research, service, and outreach activities.

Extramural researchers addressed the greatest number of goals in CON, followed by AFF, SPS, and MNF.

95% of all strategic goals were addressed in FY2016. Extramural researchers addressed 50% of all strategic goals.

Figure 9 shows the number of strategic goals by sector and the number of goals addressed by intramural researchers, extramural researchers, or both. Figure 9 also shows which goals were not addressed or were inactive in FY2016. In FY2016, research projects addressed 104 of the 109 (95%) NORA strategic goals, in particular intramural studies. Extramural projects addressed 55 (50%) of the strategic goals. Extramural research in CON addressed the most goals, followed by AFF, SPS and MNF. The AFF sector's intramural and extramural research addressed all strategic goals.

Research integration was most evident in the AFF sector where intramural and extramural researchers addressed all strategic goals in this sector.

Figure 9. Integrating NIOSH Research Goals by Sector, FY2016

INTEGRATED RESEARCH ACTIVITY BY SECTOR GOALS, FY2016

To better describe NIOSH-funded research in FY2016, NIOSH reviewed, by industry sectors, the strategic goals that extramural and intramural projects addressed. The tables that follow show how extramural and intramural research projects addressed the NORA sector strategic goals. The NORA Sector Agendas webpage describes each sector's strategic goals.

Agriculture, Forestry and Fishing

Table 4 shows how FY2016 extramural and intramural research projects addressed strategic goals in the Agriculture, Forestry and Fishing Sector. Both intramural and extramural research projects addressed all nine strategic goals for this sector. Extramural projects most often (n=28) addressed the SG1 (Surveillance) strategic goal. Intramural research most often addressed SG5 (Agricultural Health).

Table 4. Agriculture, Forestry and Fishing research projects by strategic goal, FY2016

Strategic goal (SG)	Extramural projects	Intramural projects
SG1: Surveillance	28	23
SG2: Vulnerable Workers	21	23
SG3: Outreach and Partnerships	19	9
SG4: Agricultural Safety	17	5
SG5: Agricultural Health	26	27
SG6: Forestry Injuries	5	6
SG7: Forestry Illness/Disease	3	8
SG8: Commercial Fishing Injuries	4	9
SG9: Commercial Fishing Illness/Disease	6	8

Construction

Table 5 shows how extramural and intramural FY2016 research projects addressed the Construction Sector's strategic goals. Both intramural and extramural research FY2016 projects addressed 12 of 13 active strategic goals for this sector. Two strategic goals (SG2 and SG10) were inactive in FY2016. SG14: Surveillance was the most-often-addressed strategic goal in FY2016 (n=63).

Table 5. Construction research projects by strategic goal, FY2016

Strategic goal (SG)	Extramural projects	Intramural projects
SG1: Falls Prevention	1	13
SG2: Electrocution (inactive after FY2011)	0	1
SG3: Struck-by Incidents Prevention	1	9
SG4: Hearing Loss Prevention	1	5
SG5: Silica	1	26
SG6: Welding Fumes	1	17
SG7: Musculoskeletal Disorders	4	9
SG8: Safety and Health Cultures	1	11
SG9: Safety and Health Management	2	7
SG10: Industry and Work Organization (inactive after FY2011)	1	4
SG11: Training and Education	0	4
SG12: Health Disparities	1	20
SG13: Prevention through Design	1	11
SG 14: Surveillance	37	26
SG 15: Engaging Media	0	0

Healthcare and Social Assistance

Table 6 shows how FY2016 extramural and intramural research projects in the Healthcare and Social Assistance Sector addressed strategic goals. Both intramural and extramural research FY2016 projects addressed 5 of 11 strategic goals, while only intramural research supported SG8, SG10, and SG11. Research projects did not support three strategic goals (SG6, SG7, and SG9), added in FY2014. Extramural research (n=9) and intramural research (n=36) most often addressed SG1: Safety Culture.

Table 6. Healthcare and Social Assistance research projects by strategic goal, FY2016

Strategic goal (SG)	Extramural projects	Intramural projects
SG1: Safety Culture	9	36
SG2: Musculoskeletal Disorders	6	12
SG3: Hazardous Drugs and Chemicals	4	35
SG4: Sharp Injuries	1	7
SG5: Infectious Disease	3	32
SG6: Zoonotic Diseases In Veterinary Medicine and Animal Care	0	0
SG7: Injuries In Veterinary Medicine and Animal Care	0	0
SG8: Respiratory Hazards In Veterinary Medicine and Animal Care	0	2
SG9: Reproductive Hazards In Veterinary Medicine and Animal Care	0	0
SG10: Physical Hazards In Veterinary Medicine and Animal Care	0	1
SG 11: Cross-cutting Issues	0	1

Manufacturing

Table 7 shows how FY2016 extramural and intramural research projects in the Manufacturing Sector addressed 10 strategic goals. Both intramural and extramural research supported six projects in FY2016, while only intramural research projects addressed SG4, SG7, SG8, and SG10. Intramural and extramural projects (n=97) most often addressed the strategic goal, SG5: Respiratory Diseases.

Table 7. Manufacturing research by strategic goal, FY2016

Strategic goal (SG)	Extramural projects	Intramural projects
SG1: Contact with Objects and Equipment	1	12
SG2: Falls	2	4
SG3: Musculoskeletal Disorders	6	24
SG4: Hearing Loss	0	11
SG5: Respiratory Diseases	7	90
SG6: Cancer	2	29
SG7: Vulnerable Populations	0	23
SG8: Small Business	0	12
SG9: Emerging Risks	3	66
SG10: Catastrophic Incidents	0	2

Mining

Table 8 shows how FY2016 extramural and intramural research projects in the Mining Sector addressed strategic goals. Projects addressed all seven strategic goals for this sector. Both intramural and extramural research projects addressed 5 strategic goals for this sector, while only intramural research projects supported SG6 and SG7. SG1: Respiratory Diseases was the strategic goal most often (n=50) addressed.

Table 8. Mining research by strategic goal, FY2016

Strategic goal (SG)	Extramural projects	Intramural projects
SG1: Respiratory Diseases	3	47
SG2: Noise-induced Hearing Loss	1	14
SG3: Musculoskeletal Disorders	2	14
SG4: Traumatic Injuries	3	25
SG5: Disaster Response and Prevention	3	31
SG6: Ground Failure Fatalities and Injuries	0	20
SG7: Interventions with New Technologies	0	11

Oil and Gas Extraction

Table 9 shows how FY2016 extramural and intramural research projects in the Oil and Gas Extraction Sector addressed strategic goals. Projects addressed 10 active strategic goals in this sector, and only intramural research projects supported nine goals. Two strategic goals (SG5 and SG7) are inactive, and research did not address SG5. Extramural and intramural projects most often addressed strategic goal SG6: Chemical Exposures (n = 27).

Table 9. Oil and Gas Extraction research by strategic goal, FY2016

Strategic goal (SG)	Extramural projects	Intramural projects
SG1: Transportation-related Injuries and Fatalities	0	8
SG2: Contact Injuries	0	2
SG3: Falls	0	2
SG4: Fires and Explosions	0	2
SG5: Improvement in Workplace Practices, Procedures and Policies (inactive after FY2011)	0	0
SG6: Chemical Exposures	1	26
SG07: Develop Industry-Specific Products (inactive after FY2014)	0	3
SG8: Fatigue	0	1
SG9: Vulnerable Workers	0	8
SG10: Small Businesses	0	2
SG11: Storage and Transportation	0	1

Public Safety

Table 10 shows how FY2016 extramural and intramural research projects in the Public Safety Sector addressed strategic goals. Research projects addressed all 18 strategic goals within this sector. Intramural projects supported 11 strategic goals, while both intramural and extramural research projects supported the other goals. Projects most often addressed strategic goal SG1: Chronic Disease in Firefighters (n=46).

Table 10. Public Safety research by strategic goal, FY2016

Strategic goal (SG)	Extramural projects	Intramural projects
SG1: Chronic Disease in Firefighters	0	46
SG2: Structural Firefighting Operations	1	18
SG3: Vehicle-related Injuries in Firefighters	0	9
SG4: Musculoskeletal Disorders	3	4
SG5: Surveillance in Law Enforcement	3	16
SG6: Vehicle-Related Injuries in Law Enforcement	0	12
SG7: Criminal Assaults in Law Enforcement	0	3
SG8: Cardiovascular Disease in Law Enforcement	1	6
SG9: Traumatic Injury in Corrections	1	4
SG10: Infectious Disease in Corrections	0	7
SG11: Occupational Stress in Corrections	2	3
SG12: Vehicle-related Injuries in EMS	0	5
SG13: Patient- and Equipment-handling Injuries in EMS	0	2
SG14: Infectious Disease and Hazardous Exposures in EMS	0	25
SG15: Work Organization in EMS	1	3
SG16: Surveillance in EMS	0	8
SG17: Injuries and Illnesses in Wildland Firefighting	0	5
SG18: Health and Safety in Wildland Firefighting	0	2

Services

Table 11 shows how FY2016 extramural and intramural research projects in the Services Sector addressed strategic goals. Projects addressed all 18 strategic goals for this sector. Both intramural and extramural research projects supported 4 strategic goals (SG3, SG10, SG16, and SG17), while only intramural research supported the other goals. Projects most often addressed strategic goal SG17: Surveillance (n=58).

Table 11. Services research strategic goal, FY2016

Strategic goal (SG)	Extramural projects	Intramural projects
SG1: Illnesses and Fatal Injuries in Auto Repair	0	4
SG2: Illnesses and Injuries in Building Services	0	11
SG3: Health Disparities in Building Services	1	3
SG4: Illnesses and Injuries in Schools	0	18
SG5: Injuries in Hotel/Motel Industry	0	5
SG6: Illnesses in Hotel/Motel Industry	0	8
SG7: Health Disparities in Hotel/Motel Industry	0	2
SG8: Injuries/Illnesses in Government	0	9
SG9: Traumatic Injuries in Recreation and Entertainment Industries	0	2
SG10: Injuries in Food Services	1	3
SG11: Violence in Food Services	0	1
SG12: Injuries/Illnesses in Telecommunications	0	4
SG13: Traumatic Injuries in Telecommunications	0	1
SG14: Temporary Labor/Contractors/ Contingent Workers	0	2
SG15: Injuries in Waste Collection, Disposal, and Recycling Industries	0	3
SG16: Musculoskeletal Disorders	2	5
SG17: Surveillance	32	26
SG18: Injuries/Illnesses in Nail and Hair Salons	1	0

Transportation, Warehousing and Utilities

Table 12 shows how FY2016 extramural and intramural research projects in the Transportation, Warehousing and Utilities Sector addressed strategic goals. Both intramural and extramural research addressed 3 out of 4 strategic goals for this sector. Projects most often addressed the strategic goal SG4: Chemical/Biological/Physical Hazards (n=34).

Table 12. Transportation, Warehousing and Utilities research by strategic goal, FY2016

Strategic goal (SG)	Extramural projects	Intramural projects
SG1: Traumatic Injuries	3	17
SG2: Musculoskeletal Disorders	4	15
SG3: Health and Wellness Programs	0	14
SG4: Chemical/Biological/Physical Hazards	2	32

Wholesale and Retail Trade

Table 13 shows how FY2016 extramural and intramural research projects in the Wholesale and Retail Trade Sector addressed strategic goals. Projects addressed all six strategic goals within this sector. Both intramural and extramural research projects supported two strategic goals (SG1 and SG2), while only intramural research supported the others. Extramural research most often addressed the strategic goal SG1: Musculoskeletal Disorders (n=3), while intramural research most often addressed the strategic goal SG6: Vulnerable workers (n=15).

Table 13. Wholesale and Retail Trade research by strategic goal, FY2016

Strategic goal (SG)	Extramural projects	Intramural projects
SG1: Musculoskeletal Disorders	3	12
SG2: Traumatic Injuries	1	7
SG3: Violence	0	4
SG4: Vehicle-related Injuries	0	5
SG5: Small Business Outreach	0	4
SG6: Vulnerable Workers	0	15

IV. FY2016 EXTRAMURAL RESEARCH OUTPUTS AND OUTCOMES

Outputs are the products of research activities. Examples include publications, reports, conference proceedings, presentations/posters, databases, tools, methods, guidelines, recommendations, education and training materials, inventions, and patents. This section describes the outputs of NIOSH-funded extramural research during FY2016 and outcomes.

SUMMARY OF PEER-REVIEWED PUBLICATIONS FOR FY2016

Publications by NIOSH-funded extramural researchers were collected from principal investigator reports to NIOSH, the NIH Reporter database, NIOSHTIC-2 database, and PubMed database. From October 1, 2015, to September 30, 2016, there were 582 publications across 287 different journals. Table 14 shows the number of publications by funding activity. Researchers published their NIOSH-funded research in an array of journals related to occupational safety and health. The journal most frequently published in was the Journal of Occupational and Environmental Medicine (n=57) followed by the American Journal of Industrial Medicine (n=30), the Journal of Agromedicine (n=19) and Journal of Occupational and Environmental Hygiene (n=17). A searchable database of NIOSH publications can be found at Grantee Award Final Reports and Publications on the OEP webpages.

Table 14. Number of publications by funding type, FY2016

Funding type	Number of publications
Education and Research Center Grant (T42)	215
Research Project Grants (R01)	158
Agricultural Safety and Health Center (U50, U54)	56
Exploratory Development Grant (R21)	58
Training Project Grant (T01, T03)	54
National Center for Construction Research and Training, State Surveillance Program (U60)	41
Total Worker Health® Center (U19)	26
Research Project Cooperative Agreement (U01)	20
Small Research Grant (R03)	11
Mentored Research Scientist Development Award (K01)	8
Mesothelioma (U19, U24)	2
Research Demonstration and Dissemination Grant (R18)	1
Conference (R13)	1
Education Projects (R25)	1
Miner Safety and Health Training Program	1
Total*	653*

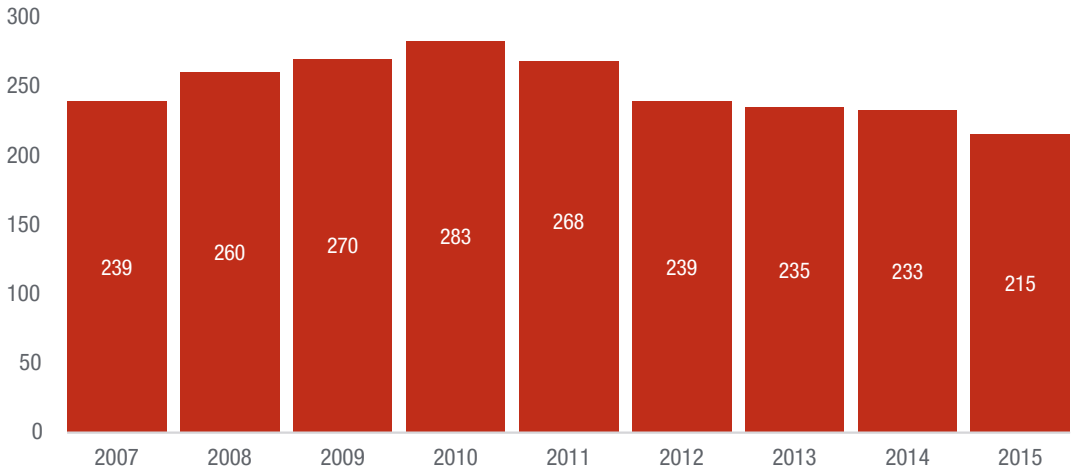
*Total exceeds 582 publications because a publication could acknowledge more than one source of funding.

V. EXTRAMURAL RESEARCH REVIEW: 2006–2016

This section of the FY2016 Annual Report focuses on the extramural research contributions during the second decade of NORA (2006–2016). The data presented show overall research activities and investment, and examples of the effectiveness and outcomes of extramural research during NORA's second decade. The *NORA Second Decade in Review Report*, and the *Sector and Cross-Sector Program Supplement* offer a full report on the NORA second decade.

ACTIVITIES AND OUTPUTS

One measure of NIOSH research activity is the number of research projects supported each fiscal year. Figure 10 shows the number of extramural research projects per year. An average of 275 active extramural research projects were funded annually during the reporting period of FY2007 through FY2015. The decade started with 239 active projects, reported a high of 283 active projects in FY2010, and ended the reporting period with 215 active projects in FY2015.



Note: An individual research project is typically active several years. Project counts are reported for each fiscal year a project was active.

Figure 10. Number of NORA extramural research projects (FY2007–FY2015)

Figure 11 shows funding of extramural research projects from FY2007 through FY2015. NIOSH funded $905.6 million in projects during the reporting period. Figure 11 shows totals in millions of dollars.

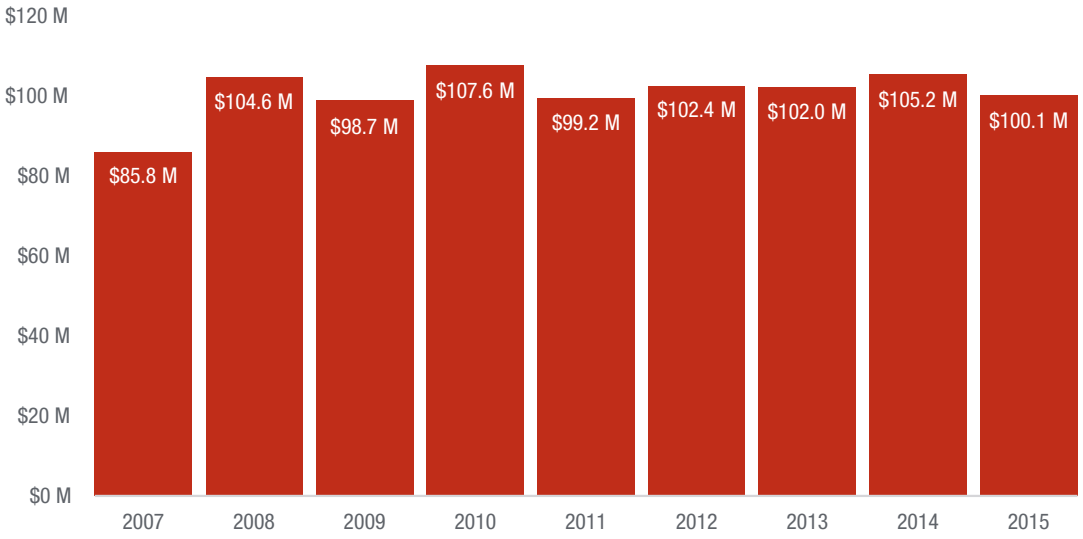


Figure 11. NIOSH investment in extramural research projects (FY2007–FY2015)

Another measure of research activity is the number and types of outputs generated by research projects. The most common output is a publication. Extramural investigators describe the results of their research in a variety of types of publications. The table below displays publication counts by type that are found in the NIOSHTIC-2 bibliographic database. The publication numbers likely underestimate publications produced during the second decade of NORA because of the limitations of the data collection methods available. Not all publications from extramural research are included in the NIOSHTIC-2 bibliographic database.

Table 15. Research outputs by type (FY2007–FY2014)

Publication Category	Extramural Publications
Journal article	2,680
Numbered publication or field study report	350
Abstracts or conference proceedings	423
Book or book chapter	102
Newsletter, trade, or lay publication	75
Other	650
Total	4,280

EFFECTIVENESS

One measure of research effectiveness in the second decade review is the degree to which research activities addressed NORA strategic goals. The table below shows the number of strategic goals within each sector program that were addressed by at least one extramural research project that contributed 50% or more effort to the sector program. During the decade, extramural research addressed 68 of the 106 (64%) NORA strategic goals. The sector with the highest number of strategic goals addressed was Public Safety, followed by Construction. All of the strategic goals in the Agriculture, Forestry and Fishing were addressed by extramural research. No goals were addressed by extramural research in the Oil and Gas Extraction sector, which was only established late in the second decade.

Table 16. Strategic Goals by Sector (FY2007–FY2014)

Sector	Number of Strategic Goals	Goals Addressed Extramural
AFF	9	9
CON	15	13
HSA	10	6
MNF	10	7
MIN	7	6
MIO	10	0
SPS	17	14
SVC	18	7
TWU	4	3
WRT	6	3
Total	106	68 (64%)

OUTCOMES

One way to measure outcomes is through citations of NIOSH-funded scientific journal articles. The Scopus database, which tracks publications and their citations, shows citations of NIOSH articles. Table 17 shows data for extramural journal articles in the NIOSHTIC-2 bibliographic database, which Scopus database listed as of September 6, 2016. More detailed analysis of publication citations is available in the *NORA Second Decade in Review Report.*

The Scopus database shows that 2,448 extramural journal articles had 42,722 citations. These data underestimate the true impact, because the Scopus database lists only 91% of extramural journal articles.

Table 17 shows citation data for all publications (intramural and extramural) and extramural publications only, by the categories of NORA sectors, All Sectors, and publications for which no sector could be assigned. The sum of publications and citations may exceed the total. Some publications were assigned to more than one sector.

Table 17. Citations of NIOSH-funded journal articles by sector

Sector	Total Number of Journal Articles	Total Number of Citations	Extramural Journal Articles	Extramural Citations
AFF	259	4,175	166	2,628
CON	299	3,314	94	934
HSA	213	2,686	79	1,048
MNF	924	24,788	285	6,589
MIN	311	3,739	21	263
MIO	5	83	0	0
SPS	106	991	29	316
SVC	152	2,163	43	395
TWU	76	1,057	12	154
WRT	22	206	7	107
All Sectors	888	14,585	707	10,819
No Sector	1,966	37,121	1,126	21,091
Totals	4,819	89,035	2,448	42,722

For a complete review of the second decade of NORA, please see the NORA Second Decade in Review Report, and the Sector and Cross-Sector Program Supplement.

VI. APPENDICES

APPENDIX 1: FY2016 NIOSH FUNDING OPPORTUNITY ANNOUNCEMENTS BY MECHANISM

Funding Opportunity	Mechanism	Title
Investigator-initiated Research		
PAR-13-245	K01	Mentored Research Scientist Development Award
PAR-13-129	R01	Occupational Safety and Health Research
PAR-12-200	R03	NIOSH Small Research Program
PAR -14-246	R13	NIOSH Support for Conferences and Scientific Meetings
PAR-12-252	R21	NIOSH Exploratory/Developmental Grant Program
Training Programs and Centers		
PAR-15-352	T03	Occupational Safety and Health Training Project Grants
PAR-15-303	T42	Occupational Safety and Health Education and Research Centers
Cooperative Agreements		
PAR-14-175	U01	Agricultural, Forestry and Fishing Safety and Health Research
PAR-14-229	U13	NIOSH Support for Conferences and Scientific Meetings
PAR-15-361	U19	NIOSH Centers of Excellence for *Total Worker Health®*
RFA-OH-14-010	U24	National Mesothelioma Virtual Bank for Translational Research
PAR-15-303	U54	National Center of Excellence for the Prevention of Childhood Agricultural Injury
PAR-14-227	U60	Workers' Compensation Surveillance
PAR-14-275	U60	State Occupational Health and Safety Surveillance Program
RFA-OH-13-001	U60	National Center for Construction Safety and Health Research and Translation
RFA-OH-14-004	U60	Miner Safety and Health Training Program—Western United States
RFA-OH-14-002	E11	Cooperative Agreement on Occupational Health with the World Health Organization: Implementing 'Global Plan of Action for Workers' Health 2008–2017'

(Continued)

Funding Opportunity	Mechanism	Title
Cosponsored Research with the National Institutes of Health		
PA-15-269	R43, R44	PHS 2014-02 Omnibus Solicitation of the NIH, CDC, FDA and ACF for Small Business Innovation Research Grant Applications
RFA-TW-14-001	U01	Hubs of Interdisciplinary Research and Training in Global Environmental and Occupational Health (GEOHealth)—Research
RFA-TW-14-002	U2R	Hubs of Interdisciplinary Research and Training in Global Environmental and Occupational Health (GEOHealth)—Research Training

APPENDIX 2: FY2016 EXTRAMURAL PORTFOLIO HIGHLIGHTS

A. Multidisciplinary Centers

NIOSH funds targeted research and outreach activities through multidisciplinary centers, with a focus on high-risk industries that contribute disproportionately to occupational injury and illness in the United States. These centers are funded through a variety of grant mechanisms, including cooperative research agreements and center training grants.

1. Agricultural Safety and Health Centers

a. Overview

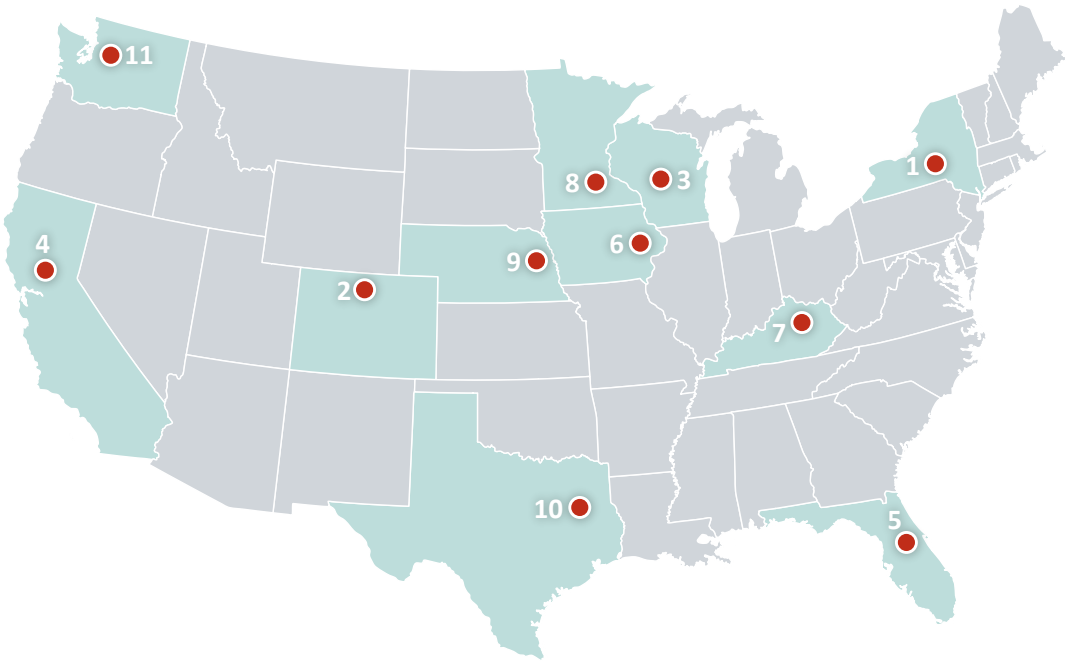
The Centers for Agricultural Disease and Injury Research, Education, and Prevention (Ag Centers) represent a major NIOSH effort to protect the safety and health of agricultural workers and their families. In 1990, the NIOSH Ag Centers were established as a part of the NIOSH Agricultural Safety and Health Initiative. The Ag Centers were established by cooperative agreement to conduct research, education, and prevention projects to address the nation's pressing agricultural safety and health problems. Geographically, the centers are distributed throughout the nation to be responsive to the agricultural safety and health issues unique to the different regions. There are currently 10 regional Ag Centers. NIOSH also supports the National Children's Center for Rural and Agricultural Safety and Health (Child Ag Center) within the National Farm Medicine Center in Marshfield, WI. The Child Ag Center's mission is to enhance the safety of all children exposed to hazards associated with agricultural work and has a national focus.

b. Public Health Relevance

In 1990, Congress established a national initiative in agriculture safety and health under Public Law 101-517. Congress anticipated that this initiative, "… when sustained over a period of time, would result in a significant and measureable impact on … health effects among rural Americans." In response, NIOSH began funding the Centers for Agricultural Disease and Injury Research, Education, and Prevention (Ag Centers) in 1991. The aim was to improve worker safety and health in the agriculture, forestry and fishing industries—occupations that consistently ranked among the most dangerous in the United States. Currently, NIOSH funds 10 regional centers and a national center that focuses exclusively on childhood agricultural risks. Although it is still true today that these occupations rank as some of the most dangerous, significant decreases in injuries, illnesses, and death among agriculture workers have occurred in the more than 25 years since the act took effect. Some of these averted injuries and deaths can be attributed to the work done by the Ag Centers.

The Ag Centers' work spans the full research-to-practice continuum. They conduct basic science to evaluate and quantify a problem, as well as translating these results into engineering controls, educational outreach efforts, or policy changes aimed at preventing or mitigating the problem. The Ag Centers' research is fundamental to creating and validating evidence-based approaches, but the real impacts occur when these approaches are actively implemented through practical education, outreach, and

NIOSH Centers for Agricultural Safety and Health



1. Bassett Healthcare
2. Colorado State University
3. National Farm Medicine Center
4. University of California, Davis
5. University of Florida
6. University of Iowa
7. University of Kentucky
8. University of Minnesota
9. University of Nebraska Medical Center
10. University of Texas Health Science Center, Tyler
11. University of Washington

prevention projects within their respective regions. Geographic diversity in agriculture, forestry and fishing activities drives the need for regional engagement by the centers.

The contributions of the Ag Centers to public health include the following:

- Integrating expertise from multiple disciplines, institutions, and community partners to solve complex problems.
- Providing a continuum of basic research through translation and outreach activities that turn findings into evidence-based prevention programs.

- Addressing the many cultural, ethnic, educational, and language obstacles that are significant barriers to safety and health for many laborers in this workforce.
- Contributing expertise to agricultural industries in the fields of medicine, nursing, industrial hygiene, epidemiology, engineering, and education.

c. Program Highlights in FY2016

Regional Centers Address Risks to Workers in Various Fishing Industries

Fishing—including shrimping, crabbing, oystering, and harvesting of other aquatic food sources—is a dangerous occupation even when compared with other high risk jobs in crop-oriented agriculture or animal husbandry. Along with the ever-present danger of drowning, other hazards may lead to musculoskeletal disorders, traumatic injuries, or mental health challenges. Complex health and safety standards, regulations, and jurisdictions—which reflect the significant variability of tasks, equipment and vessels—further obscure efforts to improve occupational health in this workforce. A few of the regional Ag Centers are in or near coastal states and focus some of their efforts in this diverse work environment.

The 10 regional Ag Centers began a new 5-year project period in FY2016. Centers with projects addressing fishing hazards include the following:

Washington: Safety Surveillance for Pacific Northwest Fisheries

This project, based at Oregon State University, is developing and testing a surveillance system for commercial fishing that will be used to evaluate and inform safety initiatives to prevent injuries. The study is using multiple data sources from NIOSH and the U.S. Coast Guard, along with insurance claims and primary data collection, to assess morbidity and mortality in the industry. A more comprehensive system for injury ascertainment should result from this project, and that will contribute to hazard assessments and intervention evaluations in this industry.

Details:
Pacific Northwest Agricultural Safety and Health Center

Texas: Preventing Injuries and Heat Related Illness in the Shrimping Industry

The Southwest Ag Center at the University of Texas at Tyler is implementing multiple projects in the shrimping industry during the 2016–2021 funding period, following a successful project addressing hazards in this industry during the prior five-year funding period. Both projects focus on hazards in the Gulf shrimping industry, particularly among Vietnamese commercial fishermen. One of the projects is evaluating the contributing factors to slips, trips, and falls while the other is assessing personal flotation device use and how this equipment can increase thermal load and present a barrier to use.

Details:
Current Projects/UT Health Northeast

Florida: Health and Safety Surveillance for Gulf Seafood Workers

The newest Ag Center, at the University of Florida, has a research project that will assess commercial fishery worker safety in the U.S. Southeast. This project focuses on the coastal Gulf of Mexico workforce in Florida and Alabama. Plans include developing, validating, and implementing an in-person questionnaire to identify hazards and adverse outcomes associated with occupational injuries, illnesses, and fatalities in the region.

Details:
Research Projects—Southeastern Coastal Center for Agricultural Health and Safety

New York: Ergonomics in the Lobster Industry and Safety Improvements for Commercial Fisherman

The NY Ag Center is currently working on two research projects in the commercial fishing industry. One of the projects, being conducted by investigators at the University of Massachusetts Lowell, has a goal to develop feasible ergonomic interventions in the lobster industry to reduce the overall rates of musculoskeletal disorders among lobster harvesters. The second project, conducted by researchers at Johns Hopkins and University of Massachusetts Amherst, is testing the acceptance and use of two mobile applications that monitor vessel motion and facilitate safety checks in order to improve overall safety and health on vessels.

Details:
Fishing Research—Northeast Center for Occupational Safety and Health, Northeast Center for Occupational Safety and Health

2. National Center for Construction Research and Training

a. Overview

The CPWR—Center for Construction Research and Training received a NIOSH National Construction Center cooperative agreement for 2014–2019 through an extramural competition. This partner, with its diverse construction community, serves as a leader in applied construction research, diffusing and disseminating effective interventions to the construction industry. The CPWR, along with its consortium of six academic partners, researches safety and health risks that construction workers face on the job, including their causes and solutions. Most of the research projects support NORA Construction Sector research goals as well as emerging issues.

b. Public Health Relevance

For the past 25 years, the CPWR—Center for Construction Research and Training has been funded through a series of competitive program announcements, as the NIOSH-sponsored Center of Excellence for Construction Safety and Health Research. For FY2016, CPWR's research activities addressed NORA Construction Goals 1 through 15, spanning applied research for hazards and health conditions, research to practice for various construction trades, emerging issues research in nanomaterials, construction industry data and tracking, and dissemination and transfer of research.

Research projects also respond to the National Academy of Sciences' recommendations for the NIOSH construction research program, including disseminating and diffusing research-to-practice solutions. CPWR has cultivated and optimized external partnerships for prevention, protections, research, and research translation for protecting U.S. construction workers.

c. Program Highlights in FY2016

CPWR's research and outreach activities in FY2016 led federal agencies to adopt evidence-based products and leverage existing partnerships to build new collaborations focused on emerging issues. Additionally, scientists outside of CPWR developed studies based on the center's research findings. Examples are described below.

OSHA Enhances Safety Climate Through CPWR Leadership Training

More than 100,000 construction workers, foremen, and other supervisory staff take the Occupational Safety and Health Administration (OSHA) 30-hour outreach training course annually. The training taught them how to identify and control occupational hazards, but it lacked leadership skills content. OSHA filled this need by adding "CPWR's Foundations for Safety Leadership training module" to its 30-hour Construction Industry Outreach Training Program. OSHA approved the newly developed 2.5 hours module as an elective in its program. CPWR developed the "Foundations for Safety Leadership training module" with feedback from OSHA outreach trainers, construction workers, safety and health professionals, and safety climate specialists. The module focuses on five leadership skills: (1) leading by example; (2) engaging team members; (3) active listening; (4) developing team members through teaching, coaching and feedback, and (5) recognizing team members. It consists of presentation slides, videos, case study scenarios, and facilitator and student guides.

Details:
Foundations for Safety Leadership

Responding to Industry Needs: Roofing r2p Partnership Leads to Multi-Trade, Labor-Management Focus on Emerging Hazard

A Roofing r2p Partnership—developed by CPWR, the National Roofing Contractors Association and the United Union of Roofers and Waterproofers & Allied Workers—led to a larger collaboration in FY2016. The Roofing r2p Partnership aims to reduce job-related injuries and illnesses in the roofing industry and has identified radiofrequency radiation as a priority area. It selected this emerging hazard because of growing concern over the surge of radiofrequency generating antennas on sites where roofing and other construction work are performed. Through these efforts, the partnership found other trade and contractor associations sharing the same concern. This led to creating the multi-trade, labor-management Radiofrequency Radiation Work Group. Its members come from eight union, trade, and professional association organizations, representing varied industries ranging from electrical work, to bricklaying, to plumbing. The work group identifies ways to

protect construction workers from overexposure to radiofrequency and has developed awareness materials and training programs on this topic. The Radiofrequency Radiation Work Group and the Roofing r2p Partnership also collaborated to develop the Radiofrequency Radiation Awareness Program**.** The program raises construction contractors' awareness of potential risks for overexposure to radiofrequency, including how to identify these hazards and work safely. The program includes presentations, videos, hazard alert cards, and a Toolbox Talk.

Details:
RF Radiation Awareness/CPWR

CPWR Study on Construction Workers' Exposure to Highly Reactive Chemicals Spawns External Research

The construction industry widely uses epoxies and isocyanates, but these highly reactive chemicals are associated with known skin disorders and asthma risks. This CPWR study aims to find accurate approaches to measure exposure to these substances and determine where exposures exist within the construction industry. Researchers are also assessing the effectiveness of current engineering controls for minimizing this hazard and developing methods to lower worker exposure. In particular, researchers are now focused on the level of isocyanate exposure to spray foam insulation installers and industrial painters—both in the air and on their skin. These scientists continuously disseminate their emerging findings to other researchers through webinars and presentations—a move that has recently spawned new research outside of CPWR. In response to rising health concerns, these external studies focus on exposure to chemicals like amine catalysts and flame retardants in spray foam insulation.

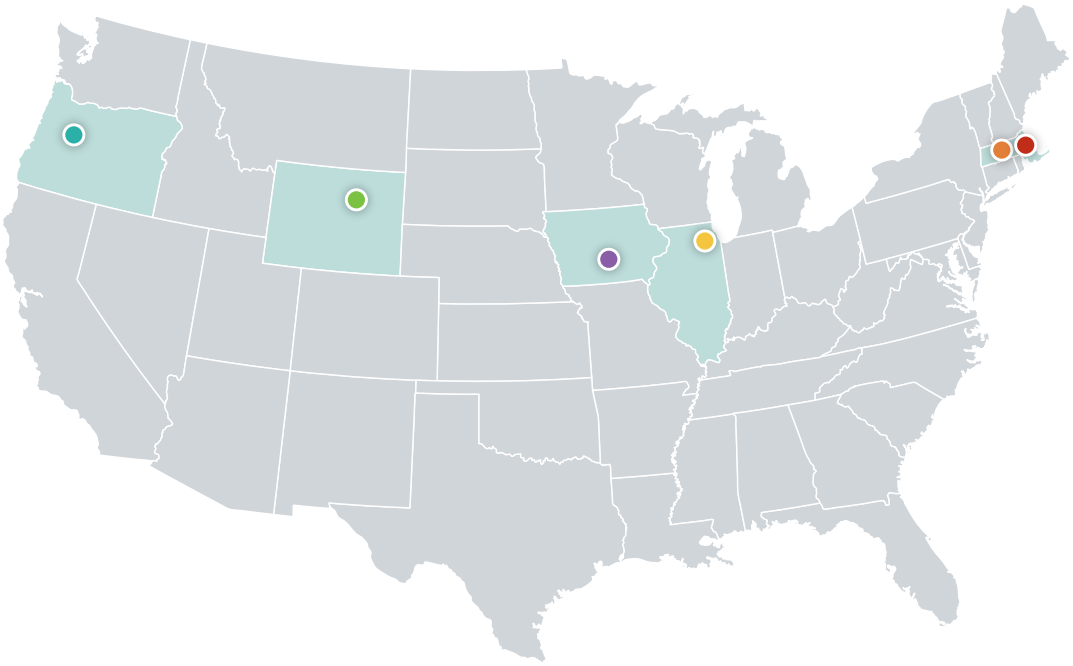
Details:
Assessment and Control of Exposures to Reactive Chemical Resins in Construction

3. Centers of Excellence for *Total Worker Health®*

a. Overview

NIOSH has funded Centers of Excellence to explore and research the concepts of *Total Worker Health* (TWH). NIOSH defines TWH as policies, programs, and practices that integrate protection from work-related safety and health hazards with promotion of injury and illness prevention efforts to advance worker well-being. In FY2016, two new Centers of Excellence, in Colorado and Illinois, joined the four existing centers in Massachusetts, Connecticut, Iowa, and Oregon. The centers' research studies integrate and cross-promote worker protection, worksite enhancement, and interventions to enhance the safety, health, and well-being of diverse workers across the United States. The effort recognizes the synergy in combining efforts to reduce personal health risk factors with traditional safety measures and approaches to reduce psychosocial stress hazards in the workplace.

Centers of Excellence for *Total Worker Health*®



Oregon Healthy Workforce Center

Center for the Promotion of Health in the New England Workplace

University of Iowa Healthier Workforce Center for Excellence

The Harvard T.H. Chan School of Public Health Center for Work, Health, & Well-being

Rocky Mountain Center for Total Worker Health

UIC Center for Healthy Work

Efforts include the following:

- Pilot testing of promising workplace policies and programs.
- Developing and disseminating best practices and tool kits.
- Developing strategies for overcoming barriers to organizations accepting and adopting comprehensive, coordinated work-based interventions to protect and promote health.
- Investigating costs and benefits associated with integrated programs.
- Promoting increased development and application of physiological and biological markers of stress, sleep, and depression, as well as using them to protect workers and improve worker health.

b. Public Health Relevance

The Centers of Excellence develop and evaluate interventions that have improved safety, health, and well-being—TWH approaches—in high-risk industries that can reduce healthcare costs when adopted on a broad scale. The centers facilitate translation from research to practice, testing the process and feasibility of implementing TWH approaches in real-world environments spanning the multiple sectors of manufacturing, healthcare, and construction. Efforts include an integrative and comprehensive approach to reduce workplace hazards and promote worker health, through its identification of the links between workplace culture and personal high-risk behaviors, as well as issues that transcend the workplace, such as work-family strain.

c. Selected Program Highlights FY2016

Labor Union Nationally Promotes CPH-NEW Peer Health Mentoring Program for Correctional Workers

The Center for the Promotion of Health in the New England Workplace (CPH-NEW) conducted a 5-year study revealing that correctional officers experience significant health declines within the first 3 years on the job. During the second phase of this study, "Health Improvement Through Training & Employee Control (HITEC II)," CPH-NEW built on the phase one research finding. CPH-NEW developed and implemented a peer health mentoring program at the Connecticut Department of Corrections (DOC) for HITEC II, targeting new cadet correctional officers to support improved health behavior. The intervention, which started in August 2011, paired a group of trained and experienced correctional workers with new recruits for a yearlong mentor relationship. These trained mentors guided the new cadets as they "learned the ropes" and dealt with job conditions impacting health. CPH-NEW reported the health-mentoring program demonstrated promising outcomes. Research results showed introducing preventive health interventions to new recruits can help correctional officers avoid early and significant health declines. In FY2016, program leadership transitioned from the research team who managed the program in previous years to facility-specific committees for program sustainability. Two DOC sites implemented the program, but their approaches differed, with one site having a participatory, officer-led "design team." A series of labor-management problem-focused kaizen (continuous improvement) teams were used at the other site.

At the kaizen team site, the Corrections Supervisors Bargaining Unit developed its own design team and created a program focused on sleep intervention. The group successfully competed for a pilot grant to develop multiple products related to the intervention, including a mobile sleep application and sleep education. The Service Employees International Union, which represents 1.5 million workers including public service workers and security guards, plans to disseminate information about this program nationally to line supervisors.

Details:
Safety & Health in Corrections History

Nearly 100 Companies, State Government, and Researchers Across the United States Use Healthy Workplace Participatory Program

The Center for the Promotion of Health in the New England Workplace developed the Healthy Workplace Participatory Program Toolkit to help employer organizations adopt and implement a TWH program approach. The toolkit engages employees in designing TWH solutions that address a wide range of issues related to the work environment, work organization, safety, and employee health. Toolkit materials are organized around initiating, implementing, and evaluating these programs. During FY2016, New Hampshire adopted the toolkit as a key benefits program for all state agencies, and it trained 30 agency wellness program coordinators for full adoption of the program. CPH-NEW also delivered Healthy Workplace Participatory Program implementation trainings to safety program managers within 39 California and 51 Massachusetts businesses. Additionally, six newly funded studies are utilizing toolkit materials as a core intervention to enhance health, safety, and well-being for low-wage workers.

Details:
Healthy Workplace Participatory Program

Investigating Cancer Risks in the Firehouse: A Total Worker Health® Collaboration with the Dana-Farber Cancer Institute and Boston Fire Department

Researchers have conducted many studies on connections between firefighters' constant exposure to toxic compounds during a fire and their cancer risk. However, this novel pilot study focused on possible links between cancer risk factors and the fire station. The Harvard Center for Work, Health, and Well-being collaborated with multiple groups on the study, including the NIOSH-funded Harvard Education and Research Center (ERC), Dana-Farber Cancer Institute, Boston Fire Department, and Boston Firefighters Union Local 718. Researchers conducted the study in four Boston Fire Department stations, after the city's Deputy Fire Chief expressed concern that local firefighters were diagnosed with and dying from cancer at high rates. Dr. Glorian Sorensen, Director of the Harvard Center for Work, Health, and Well-being, and Dr. Emily Sparer, Harvard ERC postdoctoral fellow, led the study. It explored exposure to cancer risk factors within fire stations, including diesel exhaust from idling trucks, off-gassing from bunker gear, disrupted sleep patterns, and high stress levels. The research team completed data collection in FY2016, involving air sampling and key informant interviews. Pilot study results identified fire trucks as a possible source of poor air quality in the fire stations and demonstrated positive outcomes of installing bunker gear washing machines in the facilities. Preliminary findings will inform both future research on firefighter cancer prevention and long-term workplace interventions.

Details:
Firefighters and Cancer: Dana-Farber Scientists Investigate, Study Looks at Possible Health Risks in Fire Stations

Safety and Health Improvement Program (SHIP) Disseminated by OSHA and Professional Associations

The Oregon Healthy Workforce Center designed the Safety and Health Improvement Program (SHIP) as an evidence-based workplace training intervention to reduce stress and enhance employee health, safety, and work-life balance. The program consists of family-supportive and safety-supportive supervisor training, 2 weeks of supervisor behavior tracking, facilitated team sessions with supervisors and employees, and guided follow-up. SHIP aims to enhance supervisor support, team communication, and team effectiveness, and it is shown successful in improving employee blood pressure and employee perceptions of work effectiveness and work-life balance. The center evaluated the use of SHIP with construction workers, and, in FY2016, redesigned program materials based on program feedback for utilization in multiple industries. Information about SHIP is now being disseminated by federal agencies and professional associations, including the Occupational Safety and Health Administration, American Society of Safety Engineers, and the Society for Human Resource Management.

Details:
Safety & Health Improvement Program/Oregon Healthy Workforce Center

Violence Prevention Policies, Programs, and Practices in a National Sample of Small, Mid-Sized and Large Employers

How do workplace violence prevention policies, programs, and practices vary with business size? The University of Iowa Healthier Workforce Center supported research to answer this question, because workplace violence is the fourth-leading cause of occupational fatalities in the United States, according to the Bureau of Labor Statistics. The center funded a pilot study led by University of Iowa faculty researcher, Carri Casteel, in collaboration with the Association of Threat Assessment Professionals. Casteel and her research team administered a survey to the association's membership, which includes large corporations, and also sent the survey to a national sample of small and mid-sized businesses from the Dunn and Bradstreet businesses listing. Study findings determined 97% of large companies and 91% of small and mid-sized companies have workplace violence prevention programs. Most large businesses also had policies related to reporting safety concerns, including drug use and onsite weapons, while 83% of small businesses had these policies. Additionally, larger companies had more industry standards related to workplace violence than small- and mid-sized companies.

However, small employers more often had policies allowing employers to inspect employees' work spaces and devices. Large companies had higher rates of reported violence and possession of weapons more frequently and had higher rates of investigating such incidences. The Association of Threat Assessment Professionals shared these findings with its membership, which includes safety directors at Fortune 500 companies. The study builds on past research conducted by Casteel, focused on workplace violence prevention programs (WVPPs).

Details: Prevalence and Comprehensiveness of Intimate Partner Violence Programs, Policies and Training in Mid-sized U.S. Businesses

4. Education and Research Centers

a. Overview

NIOSH supports professional training in occupational safety and health through training programs in Education and Research Centers (ERCs). ERCs are university-based, multidisciplinary centers that provide graduate training in the core and allied fields of occupational safety and health. ERCs also provide continuing education and outreach to the occupational safety and health community throughout the federal health region they serve. ERCs are interdisciplinary programs that address safety and health training and research training in a crosscutting and integrated manner. ERCs are the major part of a network of training grants that help ensure an adequate supply of qualified professional practitioners and researchers. Outreach and research-to-practice activities with other institutions, businesses, community groups, or agencies within their region are essential ERC components. Programs are encouraged to address area needs and implement innovative strategies to meet those needs, with a focus on worker health and safety.

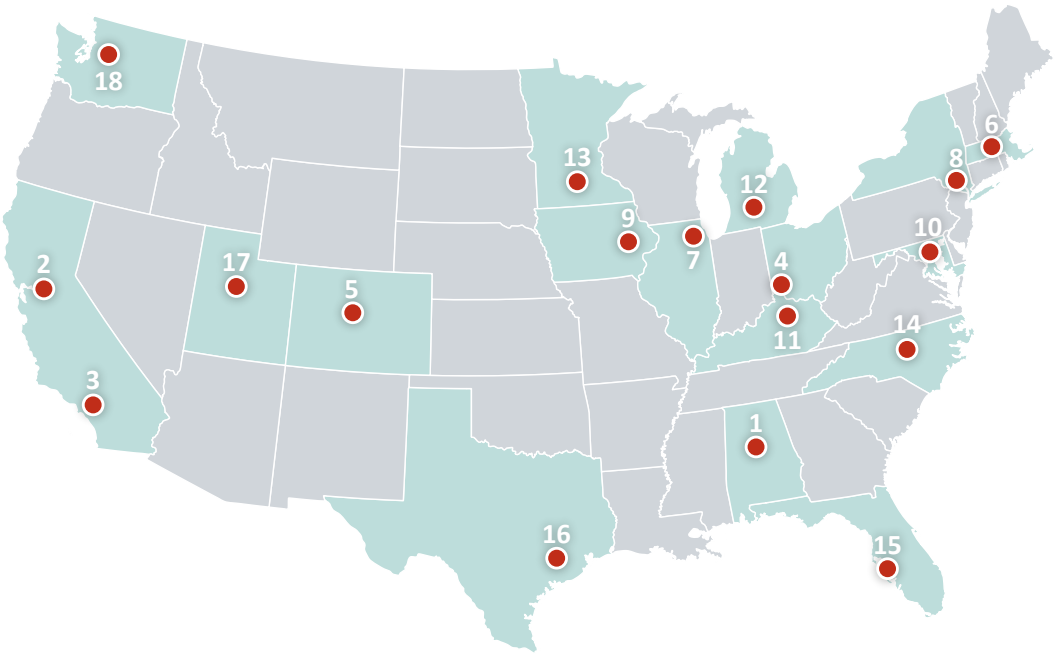
b. Public Health Relevance

The Occupational Safety and Health Act of 1970 (Public Law 91-596) establishes the NIOSH mandate to conduct education programs to ensure an adequate and steady supply of qualified personnel in this discipline. NIOSH responds to this mandate by funding training programs in the core and allied disciplines of occupational safety and health to increase the number and competencies of the occupational safety and health workforce in the United States. NIOSH-funded ERCs are central to this mandate and serve a vital role in protecting and promoting the health and safety of the nation's workforce. Aligning with the goals of Healthy People 2020—to prevent diseases, injuries, and deaths that are due to working conditions—ERCs improve occupational safety and health through education, research, and collaboration. They are the regional and national resource on these issues for business, labor, government, and the public.

ERCs meet the critical need to produce researchers and practitioners—vital to maintaining workplace health and safety—and reducing the burden of preventable work-related injury, illness, and death by performing the following actions:

- Providing the U.S. workforce with the occupational safety and health expertise needed to reduce the burden of occupational injury, illness, and death.
- Developing the major research innovations needed to prevent occupational injuries, illnesses, and fatalities in the United States.
- Providing regional and industry-specific outreach and consultation to more than 5,000 small-, medium-, and large-sized U.S. businesses annually.
- Serving as the primary source of accessible experts to the public and government leaders for occupational safety and health issues, while not duplicating any other U.S. government program.

NIOSH Education and Research Centers



1. University of Alabama at Birmingham
2. University of California, Berkeley
3. University of California, Los Angeles
4. University of Cincinnati
5. University of Colorado Denver
6. Harvard University
7. University of Illinois at Chicago
8. Icahn Mount Sinai School of Medicine
9. University of Iowa
10. Johns Hopkins University
11. University of Kentucky
12. University of Michigan
13. University of Minnesota
14. University of North Carolina at Chapel Hill
15. University of South Florida
16. University of Texas Health Science Center at Houston
17. University of Utah
18. University of Washington

c. Selected Program Highlights FY2016

Trainees, Graduates, and Employment of Graduates

In academic year 2015–2016, 252 students graduated from ERC programs with specialized training in disciplines that included industrial hygiene, occupational health nursing, occupational medicine, occupational safety, and other closely related occupational safety and health fields of study. A highlight is that the number of ERC trainees increased from 763 in FY2015 to 945 in FY2016. The following table shows the number of students enrolled, graduates, and employment status during FY2016.

Table 2-1. ERC Trainees, Graduates and Employment, FY2016

Program Area	Enrolled	Graduates	Employed or seeking occupational safety and health employment (%)
Industrial Hygiene	289	77	77 (100)
Occupational Health Nursing	131	39	37 (95)
Occupational Medicine	87	38	38 (100)
Occupational Safety	126	29	29 (100)
Other Related Disciplines	312	69	61(88)
Total	945	252	242 (96)

ERC graduates work in a variety of industries related to occupational safety. The placement of FY2016 graduates is shown in the following table by program area and work setting. Graduates who are seeking employment in the occupational safety and health field and have not taken employment outside their field are considered as remaining in the field.

Table 2-2. ERC Graduate Employment by Work Setting, FY2016

Work Setting/ Program Area	Industrial Hygiene (n=77)	Occupational Health Nursing (n=37)	Occupational Medicine (n=38)	Occupational Safety (n=29)	Other (n=61)	Total (N=242)
Academic Institution	10	1	2	4	10	27
Clinic/Hospital	5	16	21	2	5	49
Federal/ State/Local Government	15	5	5	4	19	48
Private Industry	34	4	7	12	12	69
Other OSH Employment	0	0	1	1	0	2
Seeking OSH Employment	13	11	2	6	15	47
Total	77	37	38	29	61	242

Continuing Education Outputs

Continuing education of occupational safety and health professionals is a required component of ERCs. Each year, NIOSH ERCs train thousands of these professionals around the United States through course offerings in the occupational safety and health core and related disciplines. The following table shows the continuing education activity by discipline. In FY2016, the ERCs provided more than 430,000 person hours of training to more than 53,000 occupational safety and health professionals, who took a total of 1,693 courses.

Table 2-3. Continuing Education Courses by Discipline, FY2016

Discipline	Number Courses	Number Trainees	Person-Hours of Training
Industrial Hygiene	209	5,704	52,011
Occupational Health Nursing	199	9,455	58,570
Occupational Medicine	190	5,258	19,937
Occupational Safety	807	21,867	194,987
Ag Safety and Health	50	1,565	6,261
Other	238	9,786	99,230
Total	1,693	53,635	430,996

Collaborating to Build Best Practices to Protect Animal Workers

Workers have close contact with animals in a wide range of worksites that include veterinary clinics and hospitals, zoos and aquariums, agricultural sites such as farming and fisheries, pet stores, kennels, wildlife refuges, and research sites. The animal care sector has higher-than-average rates for occupational injuries and illnesses. For example, veterinary services ranks 15th among the highest incidence rates for occupational illness and injury, according the CDC's Veterinary Safety and Health webpage. The University of Washington Northwest ERC designed a course to increase awareness, knowledge, and skills to reduce exposures to occupational hazards in an underserved workforce—animal workers. The course introduces best practices to prevent injury using a "One Health Model" that incorporates human and animal factors, as well as the physical and psychosocial environments to develop a safety culture and protocols. Topics include the hazards of chemotherapeutic agents in veterinary practices and detailed practical strategies for safe handling of these hazardous drugs, which can cause serious health and safety harm to exposed workers. The Washington State Veterinary Medical Association is collaborating with

the Northwest ERC to offer the course through its organization. This significant effort was developed through the Northwest ERC's academic program, Occupational Health at the Human-Animal Interface, an innovative, unique training program that addresses workplace hazards for this underserved worker population.

Details: Occupational Health at the Human-Animal Interface MPH Scholars Program

Preventing Workplace Violence in Correctional Institutions

Workers in healthcare settings—such as hospitals, nursing homes, and clinics—face significant risks of workplace violence. The rate of serious workplace violence incidents was more than four-times greater in healthcare settings than in private industry on average. Based on the results of a needs assessment, an ERC trainee in occupational health nursing at the University of North Carolina at Chapel Hill developed and implemented a health promotion/health protection program for nursing staff. The ERC trainee presented a training program, Workplace Incivility, to Federal Bureau of Prisons' medical staff at the Butner Correctional Facility Workforce Conference during Nurses Week, 2016. The Federal Bureau of Prisons leadership was so impressed with the program that it has been recommended for annual training to the bureau's medical staff across the United States in 122 bureau institutions.

Advancing Research on Heat Exposure among Agricultural Workers

The CDC reports heat stroke is the most serious heat-related illness and can cause death or disability. Because agricultural workers are exposed to strenuous physical labor while outdoors in extreme heat, they are at risk for heat stroke or other heat-related illnesses. The Agricultural Safety and Health Program at University California, Davis is at the forefront of research into heat exposures of agricultural workers. One NIOSH trainee is conducting a cross-sectional study involving a sample of agricultural workers in California's Central Valley, which assesses their clothing to find the optimal and feasible garments to wear when working in extreme heat. The study will determine the effects of wearing multiple layers of clothing when working in hot, outdoor conditions. This will help to develop protective steps for farm workers that will be practically implemented in agricultural and other outdoor occupational settings and help reduce the prevalence of heat-related illness among this vulnerable population.

Harvard ERC and NEC Ag Center Collaborate to Improve Winch Safety in Northeast Fishing Industry

Commercial fishing continues to be one of the most dangerous occupations in the United States, with a fatality rate in 2011 that was 35 times higher than that for all American workers. Common causes of death for fishermen are sunken vessels, falls overboard and injuries occurring onboard vessels, including entanglement in machinery. Commercial fishing operations often involve hazardous working conditions, strenuous labor, long work hours, and harsh weather. A potentially dangerous

piece of machinery on a fishing vessel is the winch—a powered, spool-like device used to wind up and wind out rope and nets. In some instances, often due to harsh weather or other hazardous working conditions, the winch mechanism can entangle crewmembers, sometimes with deadly results. Although an easily accessible shut-off switch can prevent winch entanglements, these switches are not always easy to reach in an emergency. The Harvard ERC is collaborating with the NIOSH-funded Northeast Center for Occupational Health and Safety in Agriculture, Forestry and Fishing (NEC) to disseminate and push for the adoption of a new mechanical device to enhance the safety of fishing vessel winches. The device was developed by researchers at Harvard University, who were funded through an NEC sub award. A survey, administered during the study to more than 45 active sea captains in the Gloucester and New Bedford ports in Massachusetts, found most sea captains had both a hydraulic powered winch and a winch shut-off switch on their fishing vessels, but 39% reported the switch was more than an arm's length away, which poses a challenge in an emergency. Four focus groups with trawler captains in Point Judith, Rhode Island, also provided general information on experiences, concerns, and advice on winches, as well as feedback on the proposed emergency shut-off guard. Collaborating with a private company, Rhode Island Engine, researchers designed and completed a sea trial of an innovative, drum winch emergency shut-off guard for fishing trawlers. The Active Pressure Sensitive Winch Guard was installed on the fishing vessel, *Lightning Bay*. Video showing the successful sea trial, in which the drum winch stopped within milliseconds of being activated, is available online and being disseminated by the Harvard ERC. The Harvard ERC is leading ongoing efforts to promote the device—in particular marketing to trawler captains to convince them to adopt it.

Details:

The Northeast Center for Occupational Health and Safety in Agriculture, Forestry and Fishing: Year in Review

Fatal and Nonfatal Injuries Involving Fishing Vessel Winches—Southern Shrimp Fleet, United States, 2000–2011

Partnering to Target Farmworker Safety and Health

Along with occupational hazards, farmworkers in Iowa experience chronic health conditions (such as diabetes, obesity, and hypertension) at greater rates than the general population. A NIOSH trainee partnered with Proteus, Inc., a nonprofit migrant healthcare organization, to identify occupational and nonoccupational injuries and illnesses among farmworkers in Iowa, and farmworkers use of healthcare services. With farmworkers receiving care through nonprofit or community-based healthcare organizations, an opportunity arose to disseminate safety messages and treat injuries and illnesses. The ERC trainee presented this project at the International Society for Agricultural Safety and Health Conference in June 2016.

B. Investigator-initiated Research

1. Research Grants

a. Overview

The NIOSH extramural research program supports relevant, quality scientific investigation that reduces occupational injuries, illnesses, and fatalities. NIOSH responds to that goal by funding investigator-initiated research. These diverse awards include funding for large occupational safety and health research projects (R01), small research grants (R03), and exploratory research grants (R21). The extramural research portfolio includes mentored research scientist development awards (K01) that provide mentored training for the next generation of occupational safety and health scientists. These highly competitive K01 awards provide up to 3 years of funding and a scientific focus designed to develop the skills and productivity of new career scientists. Conference grants are also awarded under research grant mechanisms (R13 and U13).

b. Public Health Relevance

Large Occupational Safety and Health Research Grants (R01)

This funding opportunity focuses on understanding the risks and conditions associated with occupational injuries, illnesses, and fatalities. It will also explore methods to reduce risks and prevent or minimize exposure to hazardous conditions in the workplace, and to translate significant scientific findings into prevention practices and products to effectively reduce work-related injuries, illnesses, and fatalities.

Small Research Grants (R03)

This grant mechanism supports different types of projects, including pilot and feasibility studies; secondary analysis of existing data; small, self-contained research projects; development of research methodology; and development of new research technology. The R03 is intended to support small research projects that can be carried out in a short time with limited resources.

Exploratory Grant Program (R21)

The R21 mechanism encourages new exploratory and developmental research projects. For example, such projects could assess the feasibility of a new area of investigation or a new experimental system that has the potential to enhance health-related research. Another example could include the unique and innovative use of an existing methodology to explore a new scientific area. These studies may involve high risk/high reward research that may lead to a breakthrough in an area. The research projects may develop new techniques, agents, methodologies, models, or applications that could greatly impact a field of biomedical, behavioral, or clinical research. Applications for R21 awards should describe projects distinct from those supported through the traditional R01 mechanism. Projects of limited cost or scope that use widely accepted approaches and methods within well-established fields are better suited for the R03 small grant mechanism.

Mentored Research Scientist Development (K01)

This K01 mechanism helps prepare the next generation of occupational safety and health researchers and educators. The funding mechanism emphasizes funding on projects that specifically address the priority goals of the National Occupational Research Agenda (NORA). These research projects may include a wide range of training modalities, reflecting the diverse approaches needed to effectively address occupational safety and health problems effectively.

Conference and Scientific Meeting (R13 and U13)

NIOSH recognizes the value of supporting high-quality scientific meetings that are relevant to the mission of preventing injuries, illnesses, and fatalities caused by hazards in the workplace. Conference grants are awarded under these research grant mechanisms.

c. Selected Program Highlights FY2016

Highlights from R01 Grants

Worn Shoe Slip Prevention Study Results in New Testing Technique and Potential Industry Standard

Slip and fall accidents are a major and growing source of occupational injuries in the United States. Workers' compensation and medical costs related to workplace falls are estimated at $70 billion a year. Heavily worn shoes increase the risk of slipping because of their reduced coefficient of friction. Worn shoes lose traction when they come into contact on the ground with fluids such as oil and water, and the shoes are no longer able to release these liquids. The fluid is then trapped in the shoe and becomes pressurized, decreasing the shoe's coefficient of friction and increasing the risk of slipping. Limited knowledge exists about the rate at which shoe tread becomes worn and the point at which shoe wear causes a reduced coefficient of friction. This knowledge gap makes it challenging for workers to select wear-resistant shoes. To address this problem, this study focuses on identifying key causes of worn shoe tread and the tread thresholds where shoes become unsafe. Although research is ongoing, the principal investigator for this study developed a new standard testing technique for measuring shoe-floor coefficient of friction. The standard is on the ballot for an American Standard Institute (ANSI) and National Floor Safety Institute (NFSI) standard. If accepted, the testing technique will become an industry standard with broad impacts on shoe manufacturers.

(R01 10940, Project Title "Impact of Worn Shoes on Slipping," Beschorner)

Hospital Violence Surveillance Study Findings in Government Report and Nursing Textbook

Healthcare workers face the risk of physical and nonphysical violence on the job. In 2014, workplace violence injured more than 9,000 healthcare employees, requiring days away from work. Workplace violence in healthcare settings happens in many forms, including an active shooter, a disruptive patient or family member, or ongoing incivility from colleagues. In hospitals, the most commonly reported form of

violence is from disruptive patients or visitors—known as Type 2 violence involving a customer/client. However, estimated reports of workplace violence against nursing staff and doctors are considered conservative, as several studies observed significant underreporting of these incidents. A lack of standard surveillance methods makes it difficult to document workplace violence in hospitals and details about these incidents. This often results in preventive policy made on an informal basis or triggered by events. This 5-year study designed and implemented a comprehensive violence surveillance system that effectively captured episodes of workplace violence against hospital workers by patients and visitors. The study involved two large hospital systems in Texas and North Carolina, consisting of six medical facilities. Researchers completed a needs assessment of workplace violence reporting systems in these hospitals and conducted a baseline assessment of the 12-month prevalence of Type 2 violence. Researchers collected baseline workplace violence data on nearly 5,400 employees in the six hospitals via a survey. Changes in hospital system leadership prevented the surveillance system from being implemented and evaluated, but researchers disseminated baseline data findings via publications. Researchers also developed recommendations for surveillance of Type 2 violence in hospitals. A U.S. Government Accountability Office report highlighted these research findings and recommendations. The textbook, "Not Part of the Job: How to Take a Stand," cited these study findings, and a Canadian-based Institute for Work & Health task force used them. The task force focuses on improving occupational surveillance in national hospitals.

Details:

Workplace Violence Prevention Course for Nurses

(R01 9697, Project Title "Development and Evaluation of a Hospital Violence Surveillance System," Pompeii)

Preventing Exposure to Tick-Borne Diseases Among Outdoor Workers

Lyme disease and other tick-borne diseases pose a significant health threat to outdoor workers, especially if they work in areas with woods, bushes, or leaf litter that are more likely to have ticks. This study assesses the effectiveness and safety of long-lasting permethrin-treated clothing when worn by outdoor workers at high risk for tick-borne diseases. Researchers recruited state and municipal employees in Rhode Island as study participants and also recruited at private organizations that employed outdoor workers. To create interest in tick bite prevention, investigators developed three short videos that train about tick safety for outdoor workers. This includes wearing long-lasting permethrin-treated clothing. Multinational electricity and gas company, National Grid, widely disseminated the videos to its workers, and the company reports they have been well received. Researchers are hoping to include National Grid workers in its study sample.

Details:

Tick Safety in the Workplace

Tick Bite: Know What to do Next

Adult Deer Ticks: Fall is their Season

Tick-Borne-Diseases

(R01 10791, Project Title "Steps to Health: Preventing Lyme Disease Exposure Among Outdoor Workers," Mather)

Highlights from R21 Grants

Cost-Efficient Screening Tool for Potential Reproductivity Toxicity in the Workplace

Workplace exposure to reproductive toxic substances like Bisphenol A (BPA) can happen through inhaling, absorbing through the skin, or eating and drinking. However, limited or no toxicological data are available on how severely such chemicals can damage a person's reproductive system. This research focused on alternative methods for testing reproductive toxicity that do not involve using animal models. The study utilized testicular cell lines to create a "mini-testis" model for the investigation, eliminating the need for more costly animal testing for impaired male reproductive function. Using the mini-testis model, the researchers developed an automated, multi-parametric, high-content analysis and high throughput screening assays, which allowed for in vitro testing of the chemicals. The testing determines which substances impair male reproductivity. While BPA has been shown to be a testicular toxicant in animal models, this study compared it with other chemicals considered to be potentially less toxic alternatives, like Bisphenol S (BPS), bisphenol AF (BPAF), and tetrabromobisphenol A (TBBPA). However, research findings determined some of these BPA-related chemicals (BPAF and TBBPA) had a more damaging effect on a cell's genetic materials than BPA. One key outcome of this study was developing the in vitro "mini-testis" model, which is a cost-efficient tool in screening whether or not a chemical could be toxic to the reproductive system. This model will provide critical data for setting workplace exposure limits to chemicals and effective prevention of reproductivity and developmental toxicity in some sectors. These include the Manufacturing Sector, Mining Sector, Oil and Gas Extraction Sector and Public Safety Sector.

(R21 10473, Project Title "A 3D Mini-Testis Model for Reproductive Toxicity Testing" Yu)

Identification of Potential New Biomarkers of Artificial Flavoring Toxicity in Workers

Flavorings are complex mixtures of natural and manmade substances. The U.S. Food and Drug Administration evaluates flavoring ingredients to determine whether they are "generally recognized as safe" to be eaten. However, even if they are safe to eat, these ingredients can be harmful to inhale in the forms and quantities to which food manufacturing and chemical industry workers may be exposed. Prior NIOSH research found occupational exposure to the flavoring chemicals diacetyl and 2,3-pentanedione are associated with significant risk for serious, irreversible lung diseases, including bronchiolitis obliterans. This study aimed to improve the diagnosis and treatment of bronchiolitis obliterans, which occurs because of workplace exposure to flavorings. Researchers aimed to identify new biomarkers of early lung injury after exposure to flavorings like diacetyl. They treated human lung cells (human bronchial/tracheal epithelial cells) with diacetyl concentrations relevant to workplace settings and observed varying protein expressions or production of proteins by the cells. Investigators found polarized and highly regulated changes in intracellular and secreted protein expression in the cells. These results indicate the cells might serve as a regulator of bronchiolitis obliterans, and they identify new potential proteins and pathways that future research can target as possible

biomarkers of flavoring toxicity. These future studies could improve early recognition of airway toxicity in the workplace related to flavorings and could identify workers at higher risk for bronchiolitis obliterans.

Details:

Proteomics of Flavorings-induced Airway Disease

Flavorings-related Lung Disease

(R21 10490, Project Title "Proteomics of Flavorings-induced Airway Disease," Foster and Palmer)

Highlights from K01 Grants

Infection Prevention Training Approved for CE Hours and Disseminated to Thousands of Nurses in New York and New Jersey

The CDC webpage, HAI Data and Statistics, reports that nearly 1 in 25 patients has a hospital infection at any given time, and 1 in 25 nurses suffers a blood-borne exposure every year. Basic procedures, termed "standard precautions," may prevent these outcomes, but healthcare workers do not always use them. This study examines organizational factors associated with higher levels of adherence to standard precautions and lower levels of healthcare worker exposures and hospital patient infections. Researchers have developed a continuing education program entitled "Standard Precautions Observation and Safety Climate Tools Research," in collaboration with Columbia University's School of Nursing, and Hackensack Meridian Health's Ann May Center for Nursing. The New Jersey State Nurses Association approved this program for 0.5 continuing education hours. Hospitals disseminated the program to their leadership and to direct-care nurses—potentially reaching 6,000 nurses. These same hospitals also participated in pilot research activities (developing and testing instruments) leading to this K01 study.

Details:

(K01 11186, Project Title "Impact of Patient Safety Climate on Infection Prevention Practices and Healthcare Worker and Patient Outcomes," Hessels)

Global Participation in Study on Injury and Illness Risk Factors for Seafarers

The ocean environment presents multiple challenges to seafaring workers' safety and health. Workers in marine industries are at higher risk for work-related fatalities than other workers. The commercial fishing industry regularly has the highest annual fatality rate among all U.S. occupations, and the water transportation industry has a fatality rate 11 times higher than the rate for all American workers. Bureau of Labor Statistics data on the U.S. workforce (2011–2015) reports about 7,300 nonfatal occupational injuries due to slips, trips, and falls for these workers. This study focuses on risk factors or hazards associated with illnesses, injuries and fatalities for seafarers. The study involves a cross-sectional sample of more than 1,000 seafarers in the United States and across seas who completed surveys. The project utilizes the survey and other international and domestic datasets to assess exposures or predictors of injury and illness for these workers, including those associated with vessel accidents. Baseline demographic and health data for seafaring workers are being linked to medical events data and job exposure to produce stratified incidence

rates by individual, job, and environment factors. Several global seafarer-related organizations now promote participation in the study, including the Sailors' Society and Seamen's Church Institute. The data from this study will be used to generate new descriptive statistics and predictors of injury and illness for this understudied workforce with significant health disparities.

Details:

Risk Factors for Injury and Illness in Seafarers

Risk Factors for Injury and Illness in Seafarers—Rafael Lefkowitz Maritime Safety & Health Studies

(K01 10681, Project Title "Risk Factors for Injury and Illness in Seafarers," Lefkowitz)

Highlights from R13 Grants

Fire Service Leaders, OSH Researchers, and Heart Disease Experts Strategize to Reduce Cardiac Disease and Death in Firefighters

Heavy physical exertion is a potential trigger for heart attacks and sudden cardiac arrest. For firefighters, these cardiac issues can link especially to alarm response and strenuous firefighting efforts. These findings are discussed in a 2016 NIOSH firefighter fatality investigation report, Firefighter Suffers Cardiac Event Following Residential Fire—NY. During FY2016, the National Fallen Firefighters Foundation hosted a conference in Washington, D.C., to address cardiac disease in the fire service. More than 60 representatives of fire service constituency organizations, fire departments, and subject matter experts attended the event. They represented fields of research associated with occupational health and cardiac health. Researchers presented the current state of the science related to cardiovascular disease and firefighters, and they collaborated with fire service leaders during the conference. The collaboration focused on a consensus-building framework to identify recommendations to reduce cardiovascular incidents. The group also identified ways to translate scientific findings and best practices to the fire service with the goal of increasing the adoption of best practices for cardiovascular disease prevention and treatment. The conference led to a white paper—developed after the event—that documents the relationship between firefighters and cardiovascular incidents. The paper also provides specific recommendations from the conference that firefighters, fire service leaders, and others can follow to reduce cardiovascular disease.

Details:

Heart to Heart: Strategizing an Evidence-based Approach to Reduce Cardiac Disease and Death in the Fire Service

(R13 11005, Project Title "Heart to Heart: Strategizing an evidence-based approach to reduce cardiac disease in the fire service," Smith)

C. Cooperative Research Agreements

Cooperative agreements give NIOSH the ability to arrange collaborative surveillance and research opportunities with state health departments, universities, labor unions, and nonprofit organizations. NIOSH funds a broad array of cooperative agreements to develop knowledge that can be used in preventing occupational diseases and injury. In FY2016, NIOSH funded the state surveillance program to support capacity development among states to conduct surveillance of occupational injuries, diseases, deaths, and hazards. NIOSH also provided new funding for workers' compensation surveillance, maintained AFF funding to support forestry safety research, and continued support of the National Mesothelioma Virtual Bank. NIOSH also supported training programs through cooperative agreements, including the Miner Safety and Health Training Program.

Unlike grants conducted independently of the sponsoring agency, cooperative agreements bring together the expertise of federal and nonfederal researchers to accomplish public health efforts that would not otherwise occur. For a cooperative agreement to be awarded, a clear need must exist to involve programmatic staff in a proposed project. NIOSH evaluates whether the cooperative agreement is of sufficient priority to warrant the committing staff resources required for a collaborative effort during the term of the cooperative agreement award.

1. State Surveillance Program

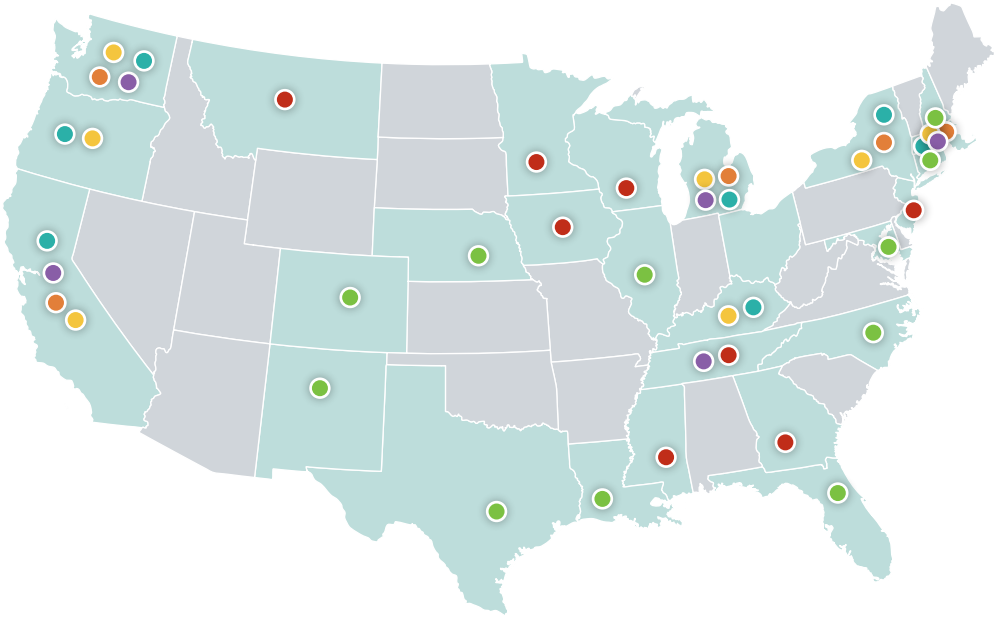
a. Overview

The state surveillance program supports developing capacity among states to do surveillance of occupational injuries, illnesses, and fatalities. It also helps expand the role of states to conduct in-depth surveillance and follow-up investigations and interventions. These local state-based skills and abilities help meet the NIOSH mandate to ensure a safe workplace. See the State Surveillance Portfolio Annual Performance Reports for more information on these state-based initiatives.

b. Public Health Relevance

The NIOSH surveillance research program acknowledges and values state programs that contribute to occupational safety and health surveillance. NIOSH gives financial and technical assistance to state health and labor agencies to develop and expand capacity for programs dealing with occupational health surveillance. The extramural surveillance portfolio comprises 26 state recipients, encompassing 49 projects for addressing work-related injuries and death, exposures and hazards, and special worker populations of interest. These programs use and disseminate occupational health surveillance data to identify the incidence and prevalence of occupational injuries, illnesses, and fatalities. They identify occupational health surveillance trends, research opportunities, emerging issues, and high-risk worker populations. They create and disseminate targeted educational and prevention materials to make them optimally beneficial, and they adapt materials to protect workers. The projects also do outreach and engage partners in public health and safety to advance "data into action."

NIOSH Sponsored State Occupational Health & Safety Surveillance Program



Fundamental Programs	Fundamental-Plus Programs	Expanded Programs	Fatality Assessment & Control Evaluation
Georgia	Colorado	California	California
Iowa	Connecticut	Kentucky	Kentucky
Minnesota	Florida	Massachusetts	Massachusetts
Mississippi	Illinois	Michigan	Michigan
Montana	Louisiana	New York	New York
New Jersey	Maryland	Oregon	Oregon
Tennessee	Nebraska	Washington	Washington
Wisconsin	New Hampshire		
	New Mexico		
	North Carolina		
	Texas		

Respiratory Diseases Projects	Workers' Compensation and Other Surveillance
California	*California
Massachusetts	*Massachusetts
Michigan	*Michigan
New York	*Ohio
Washington	*Tennessee
	Washington

*Date updated 2016. Lists 26 awards, including workers compensation surveillance awards.

c. Selected Program Highlights FY2016

Cleaning for Asthma-Safer Schools Receives National Recognition

California's Work-Related Asthma Prevention Program (WRAPP) continues to achieve national recognition of its Cleaning for Asthma Safe Schools (CLASS) Program. The program assists state K–12 school districts transition to asthma-safer cleaning products and practices through tools like the *Healthy Cleaning & Asthma-Safer Schools: A How-To Guide*. In FY2016, the National Public Health Information Coalition honored the CLASS Program's guide with a bronze medal for excellence in public health communication. The guide is also now included in the application and scoring criteria for the U.S. Department of Education Green Ribbon Schools Program award. This award nationally recognizes schools, districts, and postsecondary institutions for exemplary environmental health practices. These include reducing environmental impact and costs, along with improving the health and well-being of students and staff. California's Department of Education is now promoting the guide as a resource to help schools improve air quality and become a U.S. Department of Education Green Ribbon Schools Program awardee.

Details:
Cleaning for Asthma-Safe Schools (Class)
U.S. Department of Education Green Ribbon Schools

FMCSA Revises Rule on Passenger Safety Belt Usage in Commercial Motor Vehicles

The Federal Motor Carrier Safety Administration (FMCSA) revised a regulation on the use of commercial motor vehicle passenger safety belts, based on research from the Kentucky Occupational Health and Safety Surveillance Program. The study focused on the increased odds of semi-truck crash injuries when seat belts are not worn. It was published in the *Journal of Safety Research*.[†] The final revised FMCSA rule[‡] requires passengers in commercial motor vehicles to wear safety belts whereas only the driver was previously required to do this. The rule took effect August 8, 2016.

Details:
Motor Vehicle Injuries among Semi Truck Drivers and Sleeper Berth Passengers
eCFR—Code of Federal Regulations

New Hampshire Surveillance Research Results in New Safety and Heath Trainings

The New Hampshire Occupational Health Surveillance Program partnered with the State Office of Rural Health to publish a report on farm injury surveillance. The document, *Identifying the Gaps in the Methodology of New Hampshire Farm Injury*

[†]Bunn T, Slavova S, Sobertson, M [2013]. Motor vehicle injuries among semi truck drivers and sleeper berth passengers. J Safety Res *44*:51–55, http://doi.org/10.1016/j.jsr.2012.09.003

[‡]Driving of commercial motor vehicles: Use of seat belts. 49 CFR 392.16 (2017).

Surveillance Using Hospital Discharge Data, was published in December 2015. Dartmouth College is now using information from the report as it engages in discussions with a large medical facility to start a new training for rural medical providers on farm-specific health issues. The New Hampshire Occupational Health Surveillance Program also published findings in FY2016 from a survey, administered to state agencies to assess knowledge and prevention of tick-borne disease in outdoor workers. The surveillance program collaborated with the state's Environmental Public Health Tracking Program to release these results in the document, *Tickborne Disease Prevention Among State Agencies.* The state's Bureau of Infectious Disease Control is now partnering with the New Hampshire Occupational Health Surveillance Program to use the data to develop and implement peer to peer training programs for prevention of tick-borne disease.

Details:
Identifying the Gaps in the Methodology of New Hampshire Farm Injury Surveillance Using Hospital Discharge Data
Tickborne Disease Prevention Among State Agencies

Widespread Use and Dissemination of Washington State's TIRES Project

In Washington State, the trucking industry has high workers' compensation claim rates and costs. Past research by Washington State's Safety and Health Assessment and Research for Prevention (SHARP) Program indicates the most common and costly injuries include musculoskeletal disorders, falls, and motor vehicle collisions. In response to this problem, the SHARP Program developed the Trucking Injury Reduction Emphasis through Surveillance (TIRES) project. TIRES researchers partnered with occupational safety and health stakeholders in the trucking industry, such as safety and health professionals and employers, to develop educational materials. These products focus on identifying workplace hazards and providing low-cost, simple solutions to prevent injuries. In FY2016, more than 150,000 people accessed TIRES publications online via the project website, Trucking Injury Reduction Emphasis. TIRES training materials are used as a major component of the Washington Teamsters Training—a train-the-trainer program for the trucking and construction industries. TIRES researchers also developed an online simulation training for young truck drivers, safety directors, and company leaders, in response to requests for more interactive education. These tools have been downloaded more than 30,000 times all over the world, including by TIRES partners in the Alabama Trucking Association Workers' Compensation Fund, the Motor Carriers of Montana, and Safety Driven—Trucking Safety Council of British Columbia.

Details:
Trucking Initiative

OR-FACE Partners with Insurance Carrier to Prevent Agricultural-related Fatalities among Young and Older Workers

A higher fatality risk among agricultural workers younger than 19 and older than 65 led the Oregon Fatality Assessment and Control Evaluation (OR-FACE) Program

to collaborate with the State Accident Insurance Fund (SAIF) Corporation. SAIF is Oregon's largest workers' compensation insurance carrier. The partnership focused on reaching this target population through developing a training module included in the 2015–2016 annual SAIF Safety Seminar Series. The module covers topics like risk assessment, hazard identification, and cause analysis of an OR-FACE investigation related to the death of a vineyard worker who fell from a trailer. The training is offered in English and Spanish, and 2,500 people attended 27 English trainings in Oregon between November 2015 and March 2016. Nearly 680 people attended eight trainings offered in Spanish.

Raising Awareness through Media Influence

The Iowa Occupational Health & Safety Surveillance Program promotes and seeks to protect the health and safety of Iowans in the workplace through improved surveillance data, dissemination of information, and outreach activities. Program manager, Kathy Leinenkugel, appeared on a state radio show and a local television station in Des Moines this year to discuss worker injuries. Leinenkugel did an interview on this topic for the Iowa Public Radio show, "River to River," during its series on jobs and workers. She also discussed construction fall injuries in Iowa while on local CBS affiliate station, KCCI, in Des Moines.

Success in Reaching Young Workers about Health and Safety through Social Media

Young workers, ages 14 to 24, have a higher risk for occupational injuries for a multitude of reasons. The Occupational Safety and Health Administration identifies these as a lack of job experience, inability to identify workplace hazards, and reluctance to ask questions, along with the cognitive and physical developmental state of youth. The Massachusetts Youth Employment and Safety (YES) Team—chaired by the state's Department of Public Health Young Workers Project—addresses this problem by bringing together representatives from six states and two federal agencies that share responsibility for protecting youth at work. Established in 2003, the YES Team has successfully collaborated to promote safe jobs for teenage workers. The group expanded its focus in 2016 to include young adults, ages 18–24, raising new challenges to reach this target population. The team developed a social media campaign to engage young workers in workplace health and safety, as well as their on-the-job rights. "Getting hurt is not in your job description" was chosen as the campaign concept and tagline, with input from youth during focus groups. The team also created a single one-stop website with content from all agencies, including work permits, child labor laws, workplace hazards and workers' rights. All social messaging directed people to the website. Additionally, six scenarios depicting hazards in common youth jobs were designed and photographed and included the campaign tagline. The campaign included Facebook ads, tweets, blogs, and Instagram posts. During the 3 week early summer campaign, 175,390 people saw the Facebook ads, with 17,560 people taking some action such as liking or sharing them. Close to 40,000 website clicks resulted from the Facebook ads—almost double the 20,000

website clicks expected based on other similar state Department of Public Health campaigns. The social media campaign was to relaunch on Facebook in 2017, and images were to be placed on digital bill boards throughout the state and on public transportation in Boston.

Details:
Massachusetts Youth Employment and Safety Team (YES Team)

2. Training Project Grants

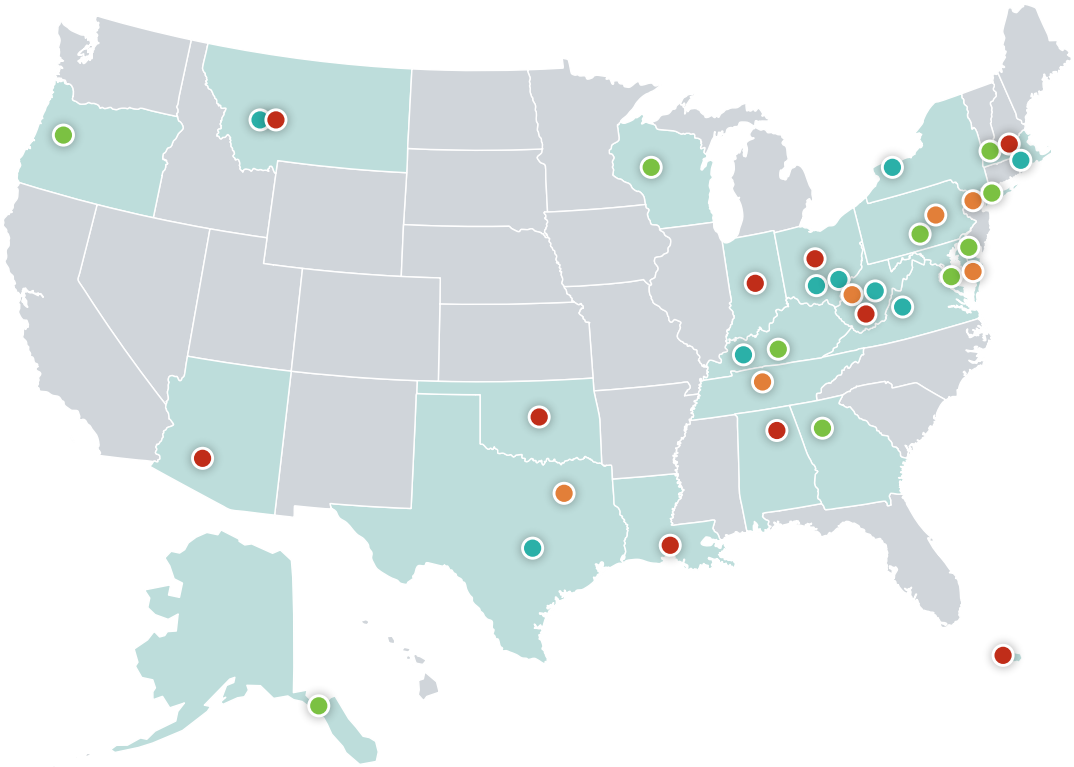
a. Overview

NIOSH supports professional training in occupational safety and health in single disciplines through Training Project Grants (TPGs). Most TPGs are academic training programs that support undergraduate and graduate training. These programs complement the national network of graduate training the ERCs provide, and they are throughout the United States. Along with TPGs for traditional degree training programs, NIOSH also supports TPGs that address the unique training needs of specialty groups. These include the Association of Occupational and Environmental Clinics (AOEC) Occupational Health Internship Program. This program provides specialty training and increases diversity among the next generation of occupational health professionals by recruiting and mentoring students from minority and immigrant backgrounds, including underrepresented minorities. The Alaska Marine Safety Education Association has a TPG that expands the network of port-based fishing safety instructors in Alaska and the United States through train-the-trainer curriculum designed for the unique needs of the commercial fishing industry. NIOSH also provides funding for a unique TPG, which is the Emergency Responder Training Program through the International Association of Fire Fighters. Additional information about this program is discussed later in this report.

b. Public Health Relevance

TPGs are one of the principal means for NIOSH to provide the nation with an adequate supply of qualified professionals to carry out the Occupational Health and Safety Act of 1970. The nation's workforce is diverse, and TPGs help train in specific disciplines where an identified need is being met. The graduates of TPGs serve a vital role in protecting and promoting the health and safety of the nation's workforce, aligning with the goals of Healthy People 2020—to prevent diseases, injuries, and deaths that are due to working conditions. Occupational safety and health training is essential to eliminate these hazards and make the workplace safer and healthier for all workers. TPGs are also important resources on occupational safety and health issues for business, labor, government, and the public.

NIOSH Training Project Grants by Discipline



Occupational Safety	Industrial Hygiene	Allied Occupational Safety & Health	Occupational Medicine
MA/Lowell	Arizona	Alaska Marine	Meharry
Montana Tech	MA/Lowell	Association of Occupational and Environmental Clinics	Pennsylvania
Murray State	Montana Tech	Connecticut	Texas/Tyler
Ohio State	North Alabama	Emory	West Virginia
Ohio University	Oklahoma	International Association of Fire Fighters	Yale
SUNY/Buffalo	Puerto Rico	MA/Lowell	
Texas A&M	Purdue	Millersville	
Virginia Tech	Toledo	Portland State	
West Virginia	Tulane	Wisconsin/Stout	
	West Virginia	Western Kentucky	

c. Selected Program Highlights FY2016

Training Project Grant Trainees, Graduates and Employment by Discipline

In academic year 2015–2016, 298 trainees graduated from the Training Project Grant academic training programs with specialized training in industrial hygiene, occupational safety, occupational medicine, and allied disciplines in occupational safety and health. Allied disciplines included occupational health psychology, risk management, occupational ergonomics and engineering, environmental health, and occupational epidemiology.

Table 2-4. Training project grant trainees, graduates, and employment by discipline, FY2016

Program area	Trainees	Graduates	Employed in occupational safety and health field or seeking advanced training (%)
Industrial Hygiene	312	98	97 (99)
Occupational Safety	344	110	109 (99)
Occupational Medicine	29	16	16 (100)
Allied Disciplines	274	74	73 (99)
Total	959	298	295 (99)

Selected Impacts of TPG Trainees

The University at Buffalo, SUNY Occupational Safety and Health TPG is adding to the next generation of Occupational Safety and Health Administration (OSHA) compliance officers. Three TPG graduates joined OSHA during the fiscal year and are serving in area offices in Philadelphia, PA, Albany, NY, and Buffalo, NY.

TPG trainees at Purdue University received awards in 2016 for their work in the field of occupational safety and health. Doctoral trainee Eric Ward earned the Eli Lilly Industrial Hygiene Student Award. Ward's research centers on the assessment of multiple metal exposure among welders using air sampling and biomarkers. Doctoral student Danielle Rolle won first place at the Indiana National Public Health Week Conference for her research poster, "Bone Manganese as a Biomarker of Cumulative Mn Exposure: a Pilot Study." The poster was co-authored by Purdue University faculty (Well, Zheng and Nie).

Montana Tech Ranked Among Top 20 Best Value Occupational Safety Training Programs

College Values Online ranked the TPG at Montana Tech of the University of Montana among the 10 best value occupational safety degree programs during FY2016. Ratings were based on multiple categories, including tuition, 20-year average net return on investment, number of students getting financial aid, and the number of minors, concentrations, and areas of emphasis offered by the program. College Values Online is an Internet resource that ranks higher institutes of learning, features the college experience and provides career information from the perspective of value.

Trainees in Occupational Health Psychology Address Critical Workplace Trends

The Occupational Health Psychology (OHP) program at the University of Connecticut is designed to recruit and train highly qualified and diverse graduate students. Training focuses in areas of psychology, public health, and nursing, with the goal of students becoming doctoral-level researchers who conduct research, focused on behavioral aspects of occupational health. Workplace trends—like downsizing, contingent labor, and longer work hours, telework, and increasing levels of automation—propel the need for studies on occupational health psychology. OHP focuses on the broad range of exposures and mechanisms, affecting the quality of working life and worker responses. Examples include how individual psychological attributes interact with job content and work organization, as well as organizational policies and practices. OHP research and practice explores interventions targeting the work environment and the individual, creating healthier workplaces to improve the capacity of workers to protect their safety and health, and maximizing workers' overall effectiveness and sense of wellbeing. As such, it fits many of the strategic goals of the NIOSH *Total Worker Health*® initiative.

3. Emergency Responder Training Program

a. Overview

NIOSH funds an Emergency Responder Training Program TPG through the International Association of Fire Fighters (IAFF). The IAFF's mission through this program is to educate emergency responders about strategies to safeguard their health and safety, and to reduce occupational injuries, illnesses, and fatalities related to emergency response, so they can better protect the communities they serve. The IAFF has had a long working relationship with NIOSH and delivers training to all disciplines in emergency response, including firefighters, emergency medical personnel, law enforcement, and public health profesionals. The IAFF's proven training record strongly emphasizes occupational safety and health as part of a comprehensive first responder training plan. IAFF's training seeks to fundamentally change knowledge, attitude, and behaviors, causing responders to adopt a safer approach to emergency response throughout their career. Training takes place across the United States and U.S. territories.

b. Public Health Relevance

This federally funded training program provides an excellent model of a delivery system for training first responders. Using a cadre of instructors who are both certified fire service instructors and hazardous materials (HazMat) responders, the IAFF offers real-world training in HazMat response that few institutions can match. Furthermore, because the IAFF brings its training directly to the students in their own communities, the IAFF is able to tailor its presentations to address the unique concerns and challenges facing local responders. IAFF training is a proven resource that directly affects decisions made in real-world scenarios firefighters experience every day, and they have developed training partnerships with thousands of fire departments throughout the United States.

c. Selected Program Highlight FY2016

The IAFF exceeded its training figures in FY2015 (90 classes and 2,107 students) by delivering a total of 103 classes to 2,476 students, with 52,040 contact hours this year.

Table 2-5. Emergency Responder Training Classes, FY2016

Class title	Duration	# of classes	# of students	# of contact hours
Confined Space Operations	24 hours	6	160	2,560
Confined Space Operations	16 hours	9	235	3,760
Illicit Drug Labs	8 hours	12	184	1,472
Emergency Response to Terrorism Operations	16 hours	6	160	2,560
First Responder Operations	24 hours	70	1,737	41,688

4. Miner Safety and Health Training Program

a. Overview

Despite many technological and work environment advances, mining remains one of the most challenging and demanding occupations in the United States. Because of the many challenges in the mining industry, the focus areas for mining training must encompass a wide range of hazards and risks.

The Mine Safety and Health Administration (MSHA) Training Academy in Beckley, West Virginia, serves the mining community in the eastern United States. The training program is not easily accessible to miners in the western United States, and certain aspects of western mining operations are not pertinent to operations in the east. To increase access to training and to address gaps related to western mining operations, NIOSH has supported miner safety and health training in the western United States since 1999. For FY2016, three programs were funded: the Colorado School of Mines, the University of Arizona, and the University of Texas at Arlington.

This training provides an integrated approach to reducing injuries to miners and other workers in mining operations and to translate research into workplace practices that (1) improve mining safety, (2) improve the safety and health of miners, (3) enhance the safety and health of other workers involved in mining operations and (4) increase the quantity of qualified mine safety and health trainers in the western United States.

Major objectives are to provide a training program that (1) addresses the training needs of miners in the western United States; (2) develops and delivers training to miners in the western United States; (3) provides qualified instructors and faculty; (4) develops and implements "train the trainer" courses; (5) evaluates training effectiveness and impact on reducing injuries and illnesses to miners; and (6) coordinates with existing training programs, such as those offered by MSHA and MSHA-funded state programs, along with and partnerships with industry, miners, and other agencies. NIOSH intends for the training provided by this program to be consistent with OSHA and MSHA guidelines, without duplicating these agencies' existing trainings.

b. Public Health Relevance

The Miner Safety and Health Training Program provides critical safety and health training to protect workers in one of the most dangerous industry sectors in the United States. This program contributes to this overall goal by taking the following actions:

- Expanding the mission of NIOSH in protecting and promoting the health of mine workers. The trainings have improved work practices, reduced work-related injury and illness, and increased the understanding of safety and health practices in western mine worksites.
- Increasing the safety focus, total health awareness, and leadership competency of miners, frontline supervisors, superintendents, and managers representing operations throughout the United States, spanning all major commodity sectors in surface and underground mining, as well as contractors.
- Directing the focus of mine-rescue training toward learning actual rescue skills rather than mine rescue contest rules, resulting in team members being better prepared to respond to all types of emergencies.

This program fills an important regional need by providing occupational safety and health training, mine emergency response and rescue training, and needs-based education to individuals and companies engaged in mining and exploration activities throughout the western United States. The program is particularly critical for underserviced populations working on mine sites, including contractors, suppliers, consultants, equipment manufacturers, and small mine operators.

The program designs and implements active learning strategies for mine safety training and has helped trainers across all commodity sectors throughout the western United States learn how to improve safety training. These activities increase capacity and improve the transfer of best practices to the workplace.

c. Selected Program Highlight FY2016

U.S. Department of Labor to Publish Higher Level Trainer Competencies and Curriculum

No existing competency model now exists for mine safety trainers in the United States that is based on human resource development research, rather than compliance. To fill this gap, the University of Arizona updated its "Higher Level Trainer" competencies and curriculum model. "Higher Level Trainer" was a scripted active learning training, intended to enhance lecture-based instruction that is focused on compliance practices. The model is now based on the Work Readiness Competencies, developed by the Department of Labor Employment and Training Administration. The Work Readiness Competencies are considered essential knowledge and skills for a successful entry into the workforce. The first three tiers of the current "Higher Level Trainer" reflects the Work Readiness Competencies. These are (a) Tier 1 (personal effectiveness); (b) Tier 2 (cognitive functions and learning styles), and (c) Tier 3 (traits and interpersonal styles necessary to function). The "Higher Level Trainer" also has two mining industry competencies that include general industry knowledge and skills, and other competencies specific to sectors in the industry. The final tier in this competency model focuses on occupational learning and development, and it is based on a validated model from the Association for Talent Development, centered on defined knowledge areas, skills, abilities, and behaviors. The official unveiling of the new "Higher Level Trainer" competencies and curriculum occurred in September 2016 at the National Mining Association Health and Safety Session in Las Vegas. The U.S. Department of Labor now plans to publish the competency model—the first national model for mine safety trainers based on human resource development knowledge.

CSM Releases Innovative and Interactive Miner Safety and Health Trainings

While frequent safety and health trainings for miners, like MSHA Part 48 and toolbox talks, focus on worker protection, this type of education requires ongoing updates to training materials. These updates ensure the courses are relevant in topic and maintain trainees' interest. The Colorado School of Mines (CSM) received comments from industry trainers, who requested new interactive training materials specific to mining and accessible online. CSM responded by developing training materials, including interactive exercises to enhance hazard recognition and a searchable fatality database, improving access to significant training information. The database is current through data published in August 2016, and five interactive trainings, based on MSHA fatality numbers, are posted on the CSM website.

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